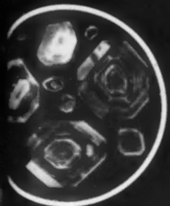
CHEMISTRY



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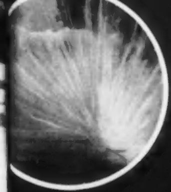

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Picking College for Science

➤ MANY THOUSANDS of young students are knocking on the doors of colleges and universities to gain admittance to courses that will train them to become scientists and engineers.

The colleges have highly perfected methods of picking the students of ability and promise they wish to admit.

But how does the potential student pick the college that will train him effectively?

Here are some suggested criteria for use by high school students and their parents in judging undergraduate colleges:

Are adequate courses offered in mathematics, physics, chemistry, zoology, botany and geology?

How good is the science faculty? Are the professors nationally recognized? This can be determined by checking the list of faculty and determining the number in the standard biographical volumes, American Men of Science and Who's Who. How many are in academies in which membership is a recognition of attainment? How many hold honorary degrees?

What alumni are eminent in science?

Are there separate buildings for science laboratories?

Does the university or college have current research projects and grants from government and foundations or both?

Does the institution confer the B.S. degree?

Is the institution on the approved list of accrediting associations?

Some of the factors that are not important in determining the science standing of an undergraduate college include:

The success of its athletic teams in intercollegiate competition.

Its geographical location or size.

Whether the institution gives graduate courses leading to advanced degrees.

Whether or not the college is coeducational.

Whether father, mother, other relatives or friends were graduated there.

CHEMISTRY

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Consulting Editor: PAULINE BEERY MACK (Editor 1927-1944)

Editor in Memoriam: HELEN MILES DAVIS (1944-1957)

➤ Birth of a *thermonuclear reaction. This streak, or smear camera, photograph of a pinch tube discharge shows the behavior of the discharge over a short interval of time. The camera looks at the discharge through a narrow slit and the film is rapidly pulled past the slit. This is one of the experiments on controlled thermonuclear reactions being carried out at the Los Alamos Scientific Laboratory as part of Project Sherwood.*

H-Bomb Reactions Controlled

by Ann Ewing

➤ Fiery hydrogen bomb reactions have been controlled momentarily at temperatures up to 6,000,000 degrees centigrade in laboratories in the U. S. and England, the atomic energy agencies of each country have reported.

This does not mean that peaceful power from taming thermonuclear reactions is going to be available soon. It does mean that scientists in both countries, and presumably Russia as well, are on the right track in their

efforts to harness H-bomb forces, but several years of research are needed before the many remaining problems will be solved.

Key to the progress announced Jan. 24 is the production of thermonuclear neutrons, fundamental nuclear particles also produced when uranium and other atoms fission, or split.

Obtaining these neutrons in a plasma of deuterium gas, even though only for thousandths or millionths of a second, brings mankind a step closer to having limitless power, using the world's oceans as a deuterium source.

The achievement was reported in several scientific papers by both U. S. and British researchers in the London scientific journal, *Nature* (Jan. 25).

The few millionths of a second during which the thermonuclear neutrons are generated by U. S. scientists is an "appreciable length of time" in this field, Dr. Arthur E. Ruark, chief of the Atomic Energy Commission's controlled thermonuclear branch, explained.

Further Work Needed

He cautioned, however, that the research was not yet at a point comparable to the start-up of the first fission reactor in December, 1942.

Much longer containment and temperatures on the order of a hundred million degrees would be required for a power-producing thermonuclear reactor.

In both the British and U. S. experiments, large numbers of neutrons have been produced. The difficult and delicate test is to make sure these neutrons result from thermonuclear reactions. They could be "false" neutrons resulting from collisions with the container's walls or from other unwanted effects.

Dr. Ruark said results to date "encourage" the belief that the undesirable "false" neutrons are not generated in such large quantities as to spoil the desired reactions. Definite proof the neutrons result from thermonuclear reactions is being sought in both countries.

With more powerful and somewhat larger apparatus, he predicted, the present hopeful results "will be exceeded."

The British research was conducted by the United Kingdom's Atomic Energy Authority at its Harwell facility. Their most promising results were obtained with ZETA, for Zero-Energy Thermonuclear Assembly, which started operation last August.

With it, temperatures of two to five million degrees centigrade were generated and the hot gas was isolated from the container's walls for periods of two- to five-thousandths of a second. The heating process was repeated every ten seconds.

Unknown Process

For useful power output, the hot deuterium gas must be kept from touching the walls for much longer times, probably several seconds.

The number of neutrons produced by each pulse of energy in the ZETA apparatus was roughly double that expected from a thermonuclear reaction at the measured temperatures. Some yet unknown process must be the reason, Dr. Lyman Spitzer, Jr., director of Princeton University Observatory, concluded after a careful analysis.

Work on pinched discharges in deuterium is now going on in a number of countries. These efforts are inspired by the hope that the gas can be made hot enough, and be confined long enough by its own magnetic field to yield fusion power, Dr. Ruark said.

When the gas is fairly dense and very hot, the nuclei, deuterons, will collide violently and repeatedly. Scientists emphasize the key is "repeatedly." For the last 25 years, researchers have fused deuterons in suitable accelerators.

Reluctant Release

The joint fusion announcement resulted from a desire on the part of AEC Chairman Lewis L. Strauss and Sir Edwin Plowden, chairman of the United Kingdom Atomic Energy Authority, to correct what they labeled "misinterpretations" about the status of progress in both countries.

The U. S. Atomic Energy Commissioners, and particularly Chairman Strauss, agreed only very reluctantly to remove U. S. studies on taming the H-bomb reactions from under security wraps.

As early as last spring, informed sources say, the AEC's apparent attitude was to hold all such work for release next September at the 1958 Atoms-For-Peace Conference. The aim was to make as big a splash in the world-wide propaganda market as the U. S. did when details concerning atomic reactors were made public at the 1955 Geneva Conference on Peaceful Uses of Atomic Energy.

Delay May Put U. S. Behind

Most scientists take a very dim view of using the security classification system for propaganda purposes. They believe progress in science is much faster when all information on scientific experiments is exchanged as freely and rapidly as possible.

Some experts connected with the thermonuclear experiments believe the U. S. delay in publishing results in this field has put this country behind such countries as England and Russia in this field.

Another by-product of the extreme secrecy surrounding thermonuclear studies, very important but seldom discussed, is the fact that few, if any, students are studying or being trained to carry on research work in the future.

On the Back Cover

➤ BRITISH ATTEMPTS *to control thermonuclear reactions generally have involved a Zero Energy Thermonuclear Assembly, ZETA. The artist's diagram of the famed "doughnut" device at Britain's Atomic Energy Research Establishment, Harwell, shows a cut-away view of the torus. The white strip in the center is the plasma, or hot gas, being "pinched" electrically. The transformer is shown at the right.*

Problems of Taming H-Bomb Reactions

Background of Thermonuclear Work

(During the January 24 press conference called in Washington to describe American and British thermonuclear research Dr. Arthur E. Ruark, chief of the U. S. Atomic Energy Commission's controlled thermonuclear branch, explained the science involved in the work. The following is part of the text of his prepared discussion.)

Magnetic Bottle

We want to explain how an electric current can form its own "magnetic bottle", permitting the gas in the discharge tube to rise to very high temperatures.

Many readers will remember that an electric current is surrounded by a magnetic field. The lines of force of this field show the direction in which a north magnetic pole of a compass would move if it were brought near the current. These lines of force are circles with their centers on the wire carrying the current (Fig. I). It makes no difference whether the current is carried by a wire or by a gas, after the fashion of a neon light. Two kinds of electric charges carry the current. First there are the negative *electrons,* passing from the negative end to the positive end. These electrons are torn loose from some of the atoms by a strong applied voltage. The parts of the atoms which are left behind are positively charged and are known as *ions.* These pass in the opposite direction, from the positive end to the negative end (Fig. II).

The Pinch Effect

When the current is very strong an entirely different behavior is found, because the current produces very large magnetic forces, which dominate the situation.

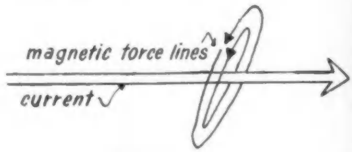


FIGURE I

It is a basic law of electricity that when a charged particle in rapid motion passes *across* magnetic lines of force, there is a push on the particle. But this push is *not* along the magnetic force lines. On the contrary, the push is at right angles to the lines of force and to the direction which the particle is heading. (The magnetic field "pushes on the shoulder" of the particle, like a football player trying to shove his opponent out of bounds.) (Fig. III)

In the case before us, the charged particles are under the combined action of the applied voltage and the magnetic force at the same time. This makes the situation a bit more complex. We shall not attempt a full explanation of the particle paths. However the net effect is that *both* the electrons and the ions are shoved toward the center line of the current. Thus the discharge automatically pinches itself down to a smaller diameter. This is the pinch effect. The

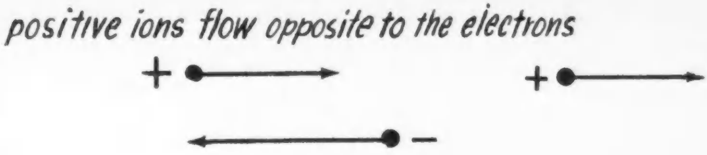


FIGURE II

gas in the current channel is compressed and gets hotter.

The pinch effect was predicted theoretically in 1934 by Dr. Willard Bennett, now at the Naval Research Laboratory.* To the best of our knowledge, the first clear experimental proof of the effect was supplied in 1951 by Dr. A. A. Ware, now at the laboratories of Associated Electrical Industries. Pictures of the pinch discharge have been published by the Los Alamos group in the Journal of Applied Physics, *28*, page 519, for May, 1957.

Why The Pinch Is Studied

Work on pinched discharges in heavy hydrogen (deuterium) is now going on in a number of countries. These efforts are inspired by the hope that the gas can be made hot enough, and be confined long enough by its own magnetic field to yield fusion power. When the gas is fairly dense and very hot, the nuclei, the deuterons, will collide violently and repeatedly.

Here the emphasis is on the word *repeatedly*. For the last quarter century, people have been causing deuterons to fuse. This is done with a suitable accelerator. A stream of deuterons is fired at a target which contains deuterium. Each bombarding deuteron encounters a number of other deuterons before it comes to rest in the target, but only a small number of the collisions are effective. Most of the bombarding deuterons are simply wasted without being transmuted.

The goal of the current research is to improve this situation. In the hot gas of a pinch tube all the deuterons are moving. If one deuteron is slowed down, it transfers part of its energy to another, which in turn may pass the energy on to still another, and so on. This argument shows in a general way how essential it is to make the gas very hot and fairly dense, and to confine it as long as possible.

Fusion Not Always Thermonuclear

Here we should explain the nuclear reactions which occur when two deuterons react. In about half the collisions the nuclear material is rearranged to give a proton and a triton, which separate with great speed. In the other $\frac{1}{2}$ of the reactions the products are a neutron and a nucleus of Helium-3. In both cases there is a great release of nuclear energy.

The neutrons escape freely through the walls of the tube and can be studied outside with a variety of detection instruments.

If two ions collide and fuse we call this a fusion reaction. If two ions in

* The pinch effect was first noted in liquids, not in gases, by E. Northrup in 1907 during a study of conduction of electrical currents in mercury.—Ed.

a *uniformly* hot gas collide and fuse we call this a thermonuclear reaction. (The 2 words have been used interchangeably in the vernacular, but this is to be regretted.)

Even in a very hot gas (plasma) a collision between two ions resulting in fusion is rare. The vast majority of collisions simply result in an exchange of energy between the two ions similar to the collision of two billiard balls. If a "hot" ion is to stay hot, until it makes a fusion collision, it must only collide with other hot particles and not with cool ones. Otherwise it will be rapidly cooled. Thus if we could make a gas *uniformly* hot, we would greatly increase the possibility that fusion reactions will take place, for a given amount of energy input to the gas. This condition of uniformly hot ions is very desirable since it means that we could produce the most fusion energy output for a given energy input. (The ratio of output to input primarily determines the possibility of making an efficient fusion reactor.) Herein lies the importance of trying to approach the condition of uniformity as closely as possible.

The observation of neutrons in our experiments is one indication that the gas is hot enough to produce thermonuclear reactions. But such observations cannot be expected to prove that the gas is *uniformly* hot, and hence that we have achieved conditions most favorable to producing power by fusion.

Instability Of The Pinch

In this country, experimental work on the pinch effect has been going on at Los Alamos and at the Radiation Laboratory of the University of California for a number of years. The early efforts brought some troubles to light. The discharge would wander to the wall, liberating impurities from it and cooling off the hot gas. Measures to prevent this were ineffective. At that time the behavior of the gas was not well enough understood.

It is now understood that when the

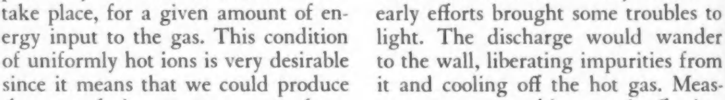


FIGURE III

pinch wanders a little from its central position, the distortion of the magnetic field due to the current brings extra forces into play. These forces increase the distortion of the current-channel further. Attention may be called to some diagrams and explanations of this trouble, given by Richard Post in the "Scientific American", *197, 73,* December, 1957.

How The Trouble Was Cured

Asking the pinched current to stay quietly in the middle of the tube is something like asking a boa constrictor not to constrict. Still, ways to do it were found.

The first is to apply a magnetic field along the tube before the voltage is applied. As the gas pinches down, it carries this magnetic field with it. The presence of the field inside the hot gas provides it with a kind of backbone. But the field applied along the tube (by means of a suitable coil) must be carefully chosen if good results are desired.

The second measure is to enclose the discharge in a highly conducting wall. There are two ways to do this. In one of them, a metal tube is used as the conducting wall. It must have insulating gaps to prevent short circuiting the applied voltage. In the other method, a conducting wall is provided outside an insulating wall (usually quartz).

The action of the conducting wall is as follows. When the pinched discharge wanders slightly from the central position, it induces eddy currents in the wall. By a well known law of electricity, these currents are in such a direction that their magnetic forces push the discharge back toward the center.

"False" Neutrons

This is the place to explain that when the pinch is not stabilized, there are at least two ways in which neutrons can be produced, without originating from repeated thermal collisions in the gas. First, deuterons which hit the walls can react with others which are adsorbed on the walls, or buried in the wall material. Second, if the plasma (the ionized gas) breaks up into a number of irregular current-channels, large voltages may arise between the various channels, and in other ways. Deuterons can be accelerated by these internal voltages, and when they strike their neighbors, can react just as though they had been speeded up in an ordinary accelerator.

Both these methods of producing neutrons are considered undesirable, because the number of effective collisions with the neighbors is relatively small.

There is also a complicating circumstance. It is well known that the probability of an effective nuclear collision increases very rapidly as the energy of the bombarding particle rises. For example, let us consider a thermonuclear reaction in deuterium. If one raises the temperature from five million to ten million degrees Centigrade, the power output from the nuclear collisions increases by a great factor, about sixteen fold. Under present conditions, the fastest particles are the most effective neutron producers. ber of different values for what we This means that the two unwanted processes above may give enough neu-

trons to mask the ones coming from real thermonuclear reactions.

Of course, the words "false neutrons" are merely laboratory slang. All the neutrons are alike. A neutron coming from an unwanted process carries just as much energy as one which comes from a more favored portion of the gas, which is quietly going about its business of producing thermonuclear power. What we want from the gas is *energy*. The energy released is divided between the charged particles and the neutrons produced by the transmutation. The neutrons simply happen to be a convenient tool for studying the discharge and improving its properties.

The false neutrons have been encountered by workers in several countries. Kurchatov discussed them at Harwell in 1956. In 1955 they were studied at both Los Alamos and the Radiation Laboratory of the University of California (UCRL). The UCRL results are described farther on.

A Word About Temperature

It is not quite correct to use the word temperature in describing the condition of man-made thermonuclear plasma. Originally it was used as a measure of the energy of the molecules, in cases where a body is quietly confined in a vessel, so that the various parts are all similar in their properties. This would be the case, very nearly, for a small body of gas near the center of the sun. But in a pinched discharge there are necessarily currents, and the discharge gives out X-rays in great quantity. Under such conditions one can calculate a num- may call an *effective temperature,* or *nominal temperature*. For example, from the neutron output we get a value which might be called "the temperature, judged by the neutrons". It is simply the value which the temperature would have to be, in a quiet plasma, in order to give the number of neutrons observed. Similarly, there can be a temperature calculated from the X-ray output, and so on. The various temperatures will not agree. In unskilled hands they can lead to confusion, but in the hands of experts, they can be used with confidence.

Real Problem In Pinch Research

The problem is to handle the gas skillfully so that it is as "hot" as possible and is confined as long as possible, each time a large burst of current is passed through the tube. Pinch devices are deceptively simple in structure and appearance, but their behavior is complicated. Hard work lies ahead to improve the technology, step by step. The significance of the technical papers outlined today lies more in the hopes they raise, than in the current state of the art. The Los Alamos group, in particular, is now getting pinches which are confined for a satisfactory length of time. The neutrons are emitted in such quantity, and at such times, that one infers the plasma must be well-stabilized.

The techniques here and in the United Kingdom are based on the same principles, but the apparatus employed is quite different, reflecting different judgments as to the most convenient way to proceed. Now the experimenters have something to build on, something worthwhile to study.

Russians First
To Reveal Progress

Where the U.S.S.R Stands on H-Power

by Howard Simons

➤ Russia is making substantial progress towards harnessing the H-bomb or controlling thermonuclear reactions.

This is well known to Western scientists, particularly those involved in the Anglo-American fusion experiments.

A few weeks before the U. S.-British announcement, Alexander Topchiev, secretary of the Soviet Academy of Sciences, said that recent Russian experiments in controlling thermonuclear reactions had moved the Soviet effort nearer to the building of "a reactor capable of working on heavy and super-heavy hydrogen (deuterium and tritium), and not on uranium fuel."

Although little is actually known of what the Russians are doing to harness the H-bomb, what is known has convinced Western researchers that Soviet researchers are doing original and highly expert work.

Three leading Russian nuclear scientists directly at work on fusion are Igor Kurchatov, Mikhail Leontovich and Lev Artsimovich.

It was Kurchatov who, in April 1956, startled and shook both British and American scientists by openly and frankly discussing fusion at Harwell in England. At this time, research on fusion in both Western countries was wrapped in tight security blankets.

Kurchatov, who is Russia's top atomic energy man, deliberately lectured on Soviet experiments on fusion reactions, revealing for the first time the methods used.

It is also known that the Russians are working with high energy impulse discharges much the same as Western scientists, and have obtained temperatures in excess of 1,000,000 degrees centigrade. If they had obtained this in 1956, as Kurchatov disclosed they already had, it is believed that by now they must have reached temperatures of 5,000,000 degrees centigrade or higher.

Carbon Filters Offer Smog Relief

➤ Here is good news for factory workers, hospital patients and homeowners bothered by smog: activated carbon filters in air conditioning systems hold promise of providing relief.

Experiments by Neal A. Richardson and Wilbur Middleton of the engineering department at the University of California at Los Angeles, indicated that such filters significantly reduced sensory irritation produced by Los Angeles smog in air-conditioned offices.

Office workers in downtown Los Angeles served as test subjects. Two nearly identical offices in the same building were used as "laboratories." Active filters and "dummy" filters were exchanged periodically between the air ventilating systems of the two offices. Workers did not know which system contained the real filters.

Glossary of H-Power Terms

Nucleus — The central core of an atom containing most of its mass, about which electrons revolve.

Electrons — Tiny fundamental particles, the smallest known having a negative mass, found circling atomic nuclei.

Neutrons — Neutral particles composing, with protons, the nucleus.

Protons — Positively charged atomic particles, the nuclei of common hydrogen.

Fusion — A nuclear reaction in which the nuclei of lightweight atoms combine to form heavier atoms.

Thermonuclear reactions — The fusion of two nuclei in a hot gas that is of uniformly high temperature, releasing energy. The energy source of all known stars.

Fission — The splitting of heavy nuclei, such as uranium, with release of energy.

Ion — An electrically charged atom or group of atoms, formed by the gain or loss of an electron.

Plasma — A very hot gas at low pressure composed of positive and negative ions so that the whole is electrically neutral.

"Pinch" effect — The contraction of a plasma carrying an electric current due to its magnetic field. This shrinking occurs in any gas or liquid carrying a current, such as the familiar neon tube, but is usually too small to be noticed.

"Magnetic bottle" — A plasma contained by its own and an applied magnetic field so it does not touch the walls of its container.

Hydrogen — The lightest of all known elements, with a nucleus consisting of a single proton about which a single electron revolves.

Deuterium — Heavy hydrogen, or hydrogen isotope 2, with a nucleus consisting of a proton and a neutron, and a single electron outside. About one in every 5,000 atoms of normal gaseous hydrogen is deuterium.

Deuteron — The nucleus of a deuterium atom.

Tritium — Heavy, heavy hydrogen, hydrogen isotope 3.

Conformity Can Stifle Genius

➤Do NOT STIFLE scientific genius by insisting on academic conformity, Dr. Carroll V. Newsom, president of New York University, advised in addressing the Thomas Alva Edison Foundation luncheon at which awards were made for children's and comic books.

"Scientific genius usually shows up early in life in an interest in hobbies, in home laboratory projects, in various types of collections," he said. "It must be our objective for the future to do everything possible to encourage young people, especially on the junior and senior high school levels, to participate in informal and specializd projects of a personalized nature."

H-Power Studies Aid Space Flight

➤ When man starts navigating to the moon and other planets in space ships, studies of how to tame the fearsome power of hydrogen bomb reactions for peaceful purposes may result in a feasible method of ion propulsion.

This possibility was foreseen by Dr. James L. Tuck, Los Alamos Scientific Laboratory physicist who did some of the pioneering work aimed at controlling thermonuclear reactions. Ionic propulsion would not help in lifting a space ship off the earth's surface, he said, but it could be a good way of obtaining high thrust without carrying a lot of fuel.

Dr. Tuck said the tricks learned in making a "magnetic bottle" for confining the hot gases in a peaceful hydrogen power station could probably also be applied in space propulsion. The ship could shoot rearward gases at much higher temperature with such new techniques than any material now known could withstand.

Essential to controlled hydrogen power is an understanding of magnetohydrodynamics, the study of the interaction of magnetic fields and fluids or gases. A by-product of these studies, Dr. Tuck predicted, could be a means of traveling in space without using up a great deal of mass.

He said that even if a thermonuclear reactor could not be built to produce power economically, it might prove worthwhile for space navigation.

Satellite 1958 Alpha

➤ The Explorer's birth is now officially announced to the world by the director of the Smithsonian Astrophysical Observatory, Cambridge, Mass.

Dr. Fred L. Whipple said the instrumented U. S. earth satellite will be known as Satellite 1958 alpha. It was placed in orbit at 10:55.5 p.m. EST on Jan. 31 at a point approximately 25.84 degrees north and 73.61 degrees west.

The U. S. satellite was launched by a U. S. Army Jupiter C rocket on Jan. 31 at 10:48 p.m. EST from Cape Canaveral, Fla., at 28.5 degrees north and 80.6 degrees west.

Including the empty rocket casing of the last stage, the satellite weighs about 30 pounds, is cylindrical in shape with a length of 80 inches and a diameter of six inches. It contains two radio transmitters, one making amplitude modulated transmissions at 108.3 megacycles with a power of 50 milliwatts, the other a phase modulated transmission at 108.0 megacycles with a power level of 10 milliwatts.

Information gathered by instruments in the satellite is being radioed back to earth by both transmitters. Scientific experiments include cosmic ray observations, meteoric impact and temperature measurements.

The satellite's surface is white and may be visible with binoculars under good conditions.

Dr. Whipple's birth and christening record was published in a Harvard College Observatory announcement card number 1390.

Solid Fuels Are Ready for ICBM's

➤ RELIABLE LONG-RANGE guided missiles powered by safe, easy-to-handle solid propellants will become part of America's defense system sooner than military leaders had expected, thanks to the transformation of one of the new "exotic" high-energy jet aircraft fuels into a solid form.

Other important breakthroughs are expected soon in the high-priority solid fuels program, a Defense Department guided missiles authority told CHEMISTRY.

High Priority

E. F. Sweetser, director of the tactical missile division, Office of the Director of Guided Missiles, said the new weapons will be available sooner for two reasons:

1. The entire program of solid fuels research and development has been put on a high priority basis since the launching of the first Russian artificial earth satellite; more money has been poured into the program and other major developments can be expected.

2. New solid fuels have been developed, existing solid fuels have been improved, and at least one of the new boron-based high-energy liquid jet fuels has been successfully prepared in solid form for use in solid rocket engines which means design and production of long-range missiles and launching equipment can be simplified and speeded up.

Mr. Sweetser pointed out that military leaders have long wanted missiles offering the simplicity of design and the convenience and safety of handling and storage that is to be had with solid propellants. However, a major drawback has been that solid fuels have not been as powerful as liquids.

HiCal in Solid Form

The picture is changed by the announcement from Gallery Chemical Co., Pittsburgh, and Thiokol Chemical Corp., Trenton, N. J., that solid rocket engines are being developed to use a solidified type of HiCal, one of the exotic fuels recently developed.

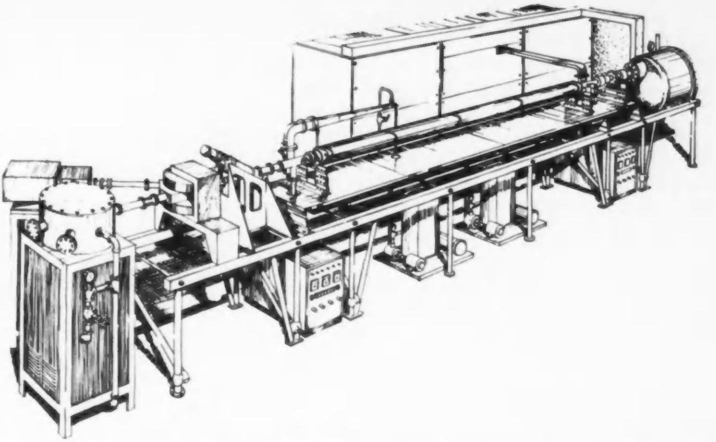
Joseph W. Wiggins, assistant technical director of Thiokol's Redstone Division, Huntsville, Ala., told Science Service in a telephone interview that use of the new fuel will not involve any major design changes in present solid rocket engines, although some modifications will have to be made.

Admitting there is some applications development work to be done, Mr. Wiggins stressed that the new fuel-engine combination is definitely out of the research stage.

One pound of uranium contains the energy equivalent of 2,700,000 pounds of coal.

At the unusually high speeds of missiles, heat causes many metals to melt, distort or deteriorate completely.

The U. S. is constructing the first nuclear-powered merchant vessel, to be in the water by 1960.



➤ THE NEW LINEAR *electron accelerator being built at Argonne National Laboratory by Applied Radiation Corporation will be housed in a shielded, earth covered, concrete building. Power supply cabinets are located at the rear in this artist's sketch. The electron gun assembly is at the far right. The long cylinder is the accelerator wave guide, and to its left is the magnetic energy analyzer. At the far left are targets set up for either the whole beam or some monoenergetic beam of electrons.*

Chemical Radiation Protection Expected

➤ BETTER PROTECTION against nuclear radiation hazards is expected to result from studies with a new high energy electron accelerator scheduled for completion at Argonne National Laboratory, Lemont, Ill., this fall.

Scientists will use the accelerator to learn more precisely just what happens in a chemical reaction set off by atomic radiation. At present, chemists have only a general notion of what happens to many life processes when nuclear radiation enters the scene.

Scientists know what materials are present in a normal body cell, and they have identified the substances present after the cell has suffered radiation damage. However, the very rapid steps and the short-lived intermediate compounds formed during radiation exposure remain, for the most part, a mystery.

Using the new linear accelerator, the Argonne chemists will make a direct frontal attack on the problem of producing, isolating and identifying the intermediate compounds.

The accelerator, under construction by Applied Radiation Corporation, Walnut Creek, Calif., will fire short, very intense bursts of electrons at cells and chemicals present in living organisms, creating enough of the intermediate materials to identify them.

When the method of radiation damage thus becomes more fully understood, chemists will then seek substances that, when injected, can either prevent the formation of the intermediates, or can combine with them to produce harmless materials.

For example, scientists have pointed out, some sugars recently have been found to reduce radiation effects in certain cases. How the sugars act is not known, but when chemists have identified more of the intermediate radiation products, they may be able to find a specific sugar or even more effective chemicals to pull the harmful intermediates out of the scene, thus stopping the cell damage process.

Argonne scientists believe knowledge gained from the accelerator experiments also will prove useful in producing new chemical products and in preserving foods by radiation.

"Scholars" Are Not Always Creative

➤ AMERICA MUST develop more inventiveness or expect to lose the economic and military race with Russia, a noted petroleum engineer and inventor has warned.

The United States has been "scooped many times" by other nations and we can expect to be surpassed scientifically again, this time by Russia, unless we seek to discover, encourage and train more young inventors, Eugene Ayres, formerly in charge of research for Gulf Refining Company, cautions in the current American Petroleum Institute Quarterly.

Mr. Ayres pointed out that the steam engine, motor car and locomotive, the internal combustion engine and many of its parts, wireless communication, X-rays and radioactivity, chemical catalysis and many other discoveries and inventions were the products of other nations.

The chemical engineer said we should have become "adjusted to the idea of other nations registering scientific firsts," but, instead, the most recent foreign invention, the Russian earth satellite, was received in the United States as a "rude shock."

The reason for the "shock," Mr. Ayres said, is that everybody was aware of the satellite "with its dramatic military implications."

The United States still ranks first, the engineer said, in the capacity to develop ideas already conceived, but he warned there is a danger in the trend to specialization and "we may find that we lack the peculiar genius required" to recognize the value of basic discoveries and inventions.

As an example, he cited the "basic research" scholar whose work is devoted to collecting and classifying facts on a particular scientific subject.

"This, while it is essential to progress, is quite as unimaginative an occupation as the application of formulae by an engineer."

He added, "in both theory and practice the 'break-through' is accomplished by inventiveness."

"What we need," Mr. Ayres concluded, "is the scholar who can escape from the grooves of accepted theoretical knowledge and the engineer who can escape from his handbooks of formulae."

First Six Months of IGY

➤ MANY IMPORTANT discoveries in various scientific fields have been made in the first six months of the 18-month International Geophysical Year, or IGY, which ends Dec. 31, 1958.

Early results of the U. S. IGY program have been reported by Hugh Odishaw, executive director of the U. S. National Committee for IGY, in the journal *Science* (Jan. 17).

The first findings from the international research program probing earth and its environment reflect the work of hundreds of scientists.

Results range from the recovery of a living organism from the record ocean depth of 16,200 feet to the discovery that there may be an atmosphere all the way from earth to the sun, consisting largely of hydrogen particles emitted by the sun.

Among the other findings reported by Mr. Odishaw:

From levels more than 1,000 feet below the surface of Greenland's ice cap, ice cores carrying a record of earth's climate for 2,000 years have been recovered.

High Altitude Studies

Upper atmospheric studies with the aid of rockets have confirmed that blackouts of shortwave radio reception are caused by an "extra" layer of ionized air extending for about 12 miles below the normal lowest point and resulting from X-rays emitted by the sun during solar flares. The D, or lowest, ionospheric layer appears to remain undisturbed during the blackout.

Radio noise at very low frequencies is thought to result from solar particles arriving in the very high atmosphere, there transferring their energy to very low frequency radio signals.

By flying and sailing instruments around the world, the earth's cosmic ray equator has been found to depart considerably from the geomagnetic equator, indicating important magnetic fields in space that deflect incoming cosmic rays. Cosmic ray measurements at a constant altitude can detect changes of latitude as small as seven miles.

Certain waves generated by earthquakes with periods of about 100 seconds, previously known only in the earth's crust, have now been identified with the next lower layer. Studies of how these waves propagate will provide new information on the distribution of materials in the earth's interior.

Exploring the structure of the Andes Mountains in South America, seismologists have found roots of unsuspected depths. By comparison, the roots under the Rocky Mountains were found unexpectedly shallow.

Scientists drifting on an ice floe only a few hundred miles from the North Pole discovered that about 12 inches of ice on the upper surface melted away, while as much as 18 to 24 inches of new ice formed on the bottom during the past summer season.

Operation of Antarctic Weather Central at Little America Station has permitted an international group of scientists to prepare the first synoptic weather charts on a daily basis. Weather forecasting in the Southern Hem-

isphere has already improved markedly because of them.

Ionosphere and Ozone

In spite of the months-long absence of sunlight, the electron concentration in the ionosphere seems to remain very high throughout the polar night, with a daily variation that is associated with geomagnetic activity.

Ozone, the triple atom form of oxygen forming a minor constituent of air, is about 25% more plentiful at Little America than in New Mexico. Because of the energy it can absorb and release, ozone is thought to play an important role in the circulation of the high atmosphere.

Another air chemical, carbon dioxide, believed to have a major role in climate changes because of its ability to act like a trap for heat radiation, occurs in about the same concentration over the Antarctic as it does in regions closer to immediate industrial contamination.

Pronounced changes in the amount of oxygen dissolved in the southern Atlantic Ocean have occurred during the past 30 years, suggesting that the deep bottom water so rich in food for fish is not being formed as fast now as it was in the past.

In the Arctic Basin where oceanographers work from camps on the frozen ocean, the track of one station carried observers over what appears to be a newly discovered underwater mountain chain.

The U. S. National Committee for IGY was established by the National Academy of Sciences. Its chairman is Dr. Joseph Kaplan, University of California physicist.

Improve Wood With Plastic Coat

➤ PLASTIC-COATED WOOD does not rot, two scientists have reported, ending a 15-year controversy among production, manufacturing and construction industries.

Based on a review of ten years of testing, the finding was viewed as giving a green light to manufacturers seeking to expand the use of plastic-coated wood for boats, truck bodies, building panels and containers.

Two main theories have given rise in recent years to strong arguments for and against the use of plastic-protected wood cores: 1. a complete covering of reinforced plastic prevents decay in wood under any moisture condition because the plastic resin sterilizes the wood surface and fungi are excluded; 2. a complete coat of reinforced plastic aids decay by causing the build-up of water condensate in the core.

A review of major testing projects and a report on a new series of tests uphold the first theory, and reject the second, Richard Mark, forest products engineer, Balsa Ecuador Lumber Corporation, New York, and Dr. Bert M. Zuckerman, wood pathology consultant, Mattapoisett, Mass., reported.

The tests, performed by Mr. Mark and Dr. Zuckerman, U. S. Government laboratories, private testing concerns as well as wood users and plastics industries, were reported to a meeting of the Society of the Plastics Industry in Chicago.

For The Home Lab:

Anthracene Brown (Anthragallol)

by Burton L. Hawk

➤ In checking over the list of synthetic dyes described in this series, we note that all of the standard colors have been prepared with the exception of brown. To fill this void, we have resurrected an almost forgotten dye . . . anthracene brown, or more often called *anthragallol*.

Anthragallol is prepared by heating a mixture of gallic acid and benzoic acid with sulfuric acid. You will require much patience in this preparation, because prolonged heating and reaction time are necessary.

Gallic Acid

First of all, we assume that gallic acid is not a normal constituent of the home laboratory, and thus we will prepare it ourselves from tannic acid. This latter compound is more readily obtainable and usually is found in the home lab. To prepare gallic acid, it is necessary to hydrolyze tannic acid by heating it with alkali. Prepare a solution of 5 grams sodium hydroxide dissolved in 25 cc. of water. To this add 6 grams of tannic acid. Stir the mixture thoroughly and heat to a temperature of 70 degrees. Keep the solution at this temperature, with stirring, for about 15 minutes. It might be a good idea to add a "pinch" of sodium bisulfite to the solution before heating. This will protect the acid from oxidation. After heating, concentrated hydrochloric acid is added, whereupon the gallic acid will be precipitated. The precipitate is filtered off rapidly and dissolved in boiling water. Allow the solution to stand in a warm place. The water will evaporate leaving behind the silky needle-like crystals of gallic acid. Before using, the compound should be thoroughly dried by heating to a temperature of 110 degrees for several minutes.

Preparation of Anthragallol

Now, we are ready to start the preparation of anthragallol. Carefully add 3.6 grams of benzoic acid crystals to 17 cc. of concentrated sulfuric acid in a beaker. Stir thoroughly, and gradually apply heat to raise the temperature to 90 degrees. At this temperature, 5 grams of the dried gallic acid, as prepared above, are added in *small* portions over a period of about an hour. After each addition, the mixture is stirred thoroughly. After all of the compound has been added, the temperature is raised to 125 degrees and kept there for 6 to 8 hours. This is rather difficult to do in a home laboratory. Of course, you do not have to heat the entire time at once. It will be permissible to heat for three hours at one time; then stopper the flask and continue heating the next day. For the heating, we suggest using a large flask. Fit the flask with a 2-hole stopper. A thermometer is inserted through one hole and down into the liquid. Through the other hole, a long piece of glass tubing is inserted. This should extend just be-

low the stopper into the flask and about two feet above the flask. With this arrangement, the solution can be heated without excessive evaporation.

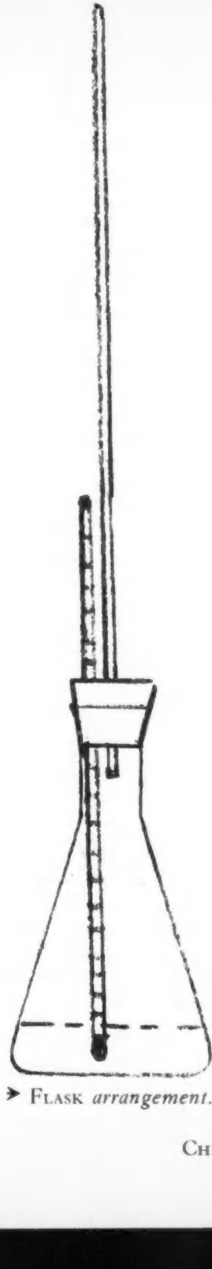
At the end of the long heating period, the hot liquid in the flask is allowed to drop slowly into 100 cc. of boiling water contained in a large beaker. This operation must be performed with great care to avoid dangerous spattering. Using a medicine dropper, allow a few drops of the mixture to drain down the side of the beaker into the boiling water. Stir thoroughly until all action ceases, then add a few more drops. This is continued until all the material is added. Remember, spattering may occur so be sure to keep your face away.

After all of the mixture has been added to the boiling water, continue to heat and stir for a few minutes; then filter the hot solution. Wash the precipitate with boiling water. Carefully scrape the product onto a watch glass and dry over very gentle heat.

The brown crystals of anthragallol are only slightly soluble in water. They will dissolve in alcohol to form a brown solution. Note that the color is very deep and only a few crystals will color a large volume of alcohol. Dissolve a few crystals in concentrated sulfuric acid. A reddish-brown solution is formed. If your anthragallol is sufficiently pure, it will form a greenish-brown solution when dissolved in ammonia water. This solution will change to blue when heated.

Use As a Dye

Anthragallol dyes wool brown. However, a mordant is required. You will recall that in mordant dyeing, the cloth is first treated with a sub-



➤ FLASK *arrangement.*

stance known as a "mordant." The mordant is taken up by the fibers of the cloth and the mordant in turn takes up the dye. The salts of chromium provide the best mordants for anthragallol. If you care to dye, you will find chromium fluoride will provid the best shades. However, if this compound is not available, try chrome alum or chromium chloride.

Parents Discourage Science and Math

➤ MANY COLLEGE students do not major in science or mathematics because of the attitudes of their parents.

A survey at the University of California at Los Angeles has shown that most parents tend to discourage youngsters, especially girls, who show a first, hesitant mathematical interest in high school.

Dislike of mathematics by parents is thought to have originated during the depression years, when mathematics was considered an economic dead-end street.

"It was considered practical at best for teaching and life insurance careers — but generally useless for industry or commercial jobs," according to Dr. Magnus R. Hestenes, chairman of UCLA department of mathematics.

Most parents offered little encouragement, the survey indicated. Asked about attitudes of parents and friends toward mathematics, the girls' answers ran along the following lines:

"My parents were just shocked — my sister said 'you'll never make it.'"

"My choice was frowned upon by skeptical friends who shudder at the sound of the word math."

"They made me feel like a freak. I feel that math is just as ordinary and respectable a major as any."

If the nation is to meet the challenge of the post-sputnik era, Dr. Hestenes believes, the next generation of mathematicians must learn from their parents that mathematics is not only "respectable" but essential to this country's educational, economic and scientific development.

Reinforced plastics are used in missiles and jets as a heat shield for metal, illustrating the extreme requirements they can meet.

Instruments used to check the electronic and mechanical systems in aircraft and missiles can measure the width of a hair at a distance equal to the length of a football field.

A new plastic petroleum will lubricate in a range of temperatures from below freezing to 150 degrees Fahrenheit.

Drawbacks of the Scholarship Plan

➤ THE ADMINISTRATION'S proposed multi-million dollar scholarship program to entice more students into scientific and engineering careers may do more harm than good.

This is the criticism of many educators and manpower experts.

The proposed program has the potential of worsening an already bad situation, they say.

The major criticism is that scholarships help students but do nothing for the colleges and universities currently in urgent need of dollars.

Student recruitment, they explain, is no longer a major problem. In many instances schools cannot take more students. Engineering enrollments, for example, were at an all-time high in 1957 and many of the nation's top engineering schools now have waiting lists extremely long.

Overcrowding Is Major Problem

The major problem is overcrowded and understaffed colleges and universities. The problem promises to get worse before it gets better. U. S. Commissioner of Education Lawrence G. Derthick recently predicted that college enrollments would more than double in the next ten years.

"The Administration in its proposed scholarship program has made no provision for helping the colleges and universities to expand their staffs and facilities," Dr. Howard Myerhoff, executive director of the Scientific Manpower Commission, says.

"There is no possible way in the foreseeable future for our engineering schools to absorb more students unless they get substantial help."

No Help to Schools

In the same vein, Dr. Eric A. Walker, vice-chairman of the President's Committee on Scientists and Engineers and president of Pennsylvania State University, said he was at odds with the proposed program for scholarships because it doesn't "help the universities at all."

One of the biggest fears if the flood gates of potential students are opened up is that academic standards will suffer. This might prove more devastating than having a shortage of students.

What is needed in any Federal program, the experts are convinced, is money for collegs and universities that will enable them to enlarge their staffs, build new buildings and facilities.

Perhaps a more serious shortage than students is that of qualified teachers — partially a result of industry having pirated professors and graduate students away from colleges and universities.

Dr. Meyerhoff's Commission, which crowed loud and strong in pre-sputnik days about the scientific and engineering manpower shortage, said that:

"The major problem is no longer one of student rcruitment but of educational quality all along the line and the provision of adequate facilities and faculty for higher education in engineering and science. We see no compelling reason for altering that basic emphasis."

Tests Not Uniform

There probably will not be uniform

tests nation-wide. In some states students will win scholarships that they could not get in other states where the educational level is higher. The tests will be more to determine general intelligence than scientific and technological ability, for while there will be preference specified for those well grounded in mathematics and science the students interested in other fields will not be eliminated.

The tests will probably be given to students in the junior year of high school or earlier, although the scholarships would be awarded only to seniors ready for college.

It will cost about $2.50 to give each test and a half-dozen private testing organizations will be eager to help the various states do the testing job.

The new Federal-state scholarship program would have little influence and will not interfere with the pioneering National Science Talent Search for the Westinghouse Scholarships, conducted by Science Service, now in its 17th year. Due to the high prestige of this selection procedure and the fact that scholarships are not contingent upon need, there will still be keen competition for these honors, even if the plan is implemented by Congress. The National Merit Scholarship and other such programs should continue unabated as a supplement to the proposed new plan.

Psoriasis Detected by Chemical Test

➤ Psoriasis, the puzzling and incurable skin disease that disfigures between 2,000,000 and 3,000,000 Americans, can now be diagnosed with chemical tests that help point the way toward a "rational" treatment for the disease.

This was reported by Dr. Peter Flesch, University of Pennsylvania School of Medicine, Philadelphia, to a meeting of the American Academy of Dermatology and Syphilology.

Dr. Flesch and associates have found that the water-soluble substances in the horny layer of the skin are severely disturbed in psoriasis and several other scaling skin diseases. Amino acids and certain sugars behave in an abnormal way in the skin and the abnormality can be spotted with chemical tests.

The researchers were able to diagnose psoriasis in the test tube from tiny bits of scales without ever setting eyes on the patient. This represents a big change from the standard methods of diagnosing skin diseases, which have almost all been based on direct observation. The chemical tests can give a much more objective and unbiased picture of the disease than can the individual doctor.

"As a result of this research, there now are definite chemical data available which give an insight into the nature of the abnormal scaling associated with this disease. Until now, no such chemical features were known. Hence, research on this disease groped in the dark," Dr. Flesch reported.

Associated with him in the research wer Drs. Daphne Anderson Roe and Elizabeth J. Esoda of the University of Pennsylvania and Vassar College, Poughkeepsie, N. Y.

The Problem of the Elusive Element

by Norman P. Gentieu
*Foote Mineral Company, Philadelphia, Pa.**

➤ About two miles from the mainland of southeastern Sweden the island of Utö nestles like a tiny speck of rock in the bleak waters of the Baltic Sea. It is one of the many skerries in the imposing archipelago that thrusts seaward from Stockholm. In the nineteenth century it was renowned among metallurgists for its rich iron mines and beloved by the citizens of Stockholm for its excellent excursion opportunities.

However, the island's most enduring treasure lay hidden beneath the ground, until a young Swedish chemist encountered an unforeseen frustration with a nonferrous ore from its mines. Because part of the mineral disappeared when tested, the chemist extended his investigations, solved the mystery of the lost portion, and, in a brilliant climax, succeeded in discovering a new element.

José Bonifacio de Andrade Silva (1763-1838), Brazilian scientist, statesman, and poet, had discovered the ore petalite on the island of Utö. However, his original finding had remained in obscurity until 1817, when the ore was re-discovered by the metallurgist, E. T. Svedenstjerna.

This time, fortunately, the Utö mineral received more than a casual inspection. A twenty-five-year-old chemist — Johann Auguste Arfwedson — working in the laboratory of Berzelius, was requested by the great Swedish scientist to analyze the physical

➤ The Detective: *In 1817 the young Swedish chemist Johann Auguste Arfwedson found himself involved in a fascinating mystery which resulted in a startling discovery.*

and chemical properties of petalite. Thus began the exciting investigation that culminated as a happy combination of persistence and serendipity.

Chemical Detective Story

The story of this discovery possesses most of the lures of the classic mystery story together with the dramatic satisfaction of an unexpected climax. The detective is the chemist; the *mise en scène* is the mine of Utö; the significant clue is the petalite specimen; the center of investigation is Berzelius's laboratory; the pursuit is the examination of the anomalous mineral; and the denouement is the published

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report. It is true that the adventure inherent in Arfwedson's bland prose must be read between the prosaic lines he wrote in his laboratory notebook. However, the magnitude of the event far transcends the cut and dried style of its author.

A Mineral and a Beginning

Arfwedson's report begins with a cursory introduction that sets the pace for his subsequent data. We must remember that when the nineteenth century was still young, scientists soberly recorded their unembellished observations for their peers, and were not inclined to rhapsodize "in linked sweetness long drawn out."

The mine of Utö (wrote Arfwedson) *has long been of great mineralogical importance — several minerals having been discovered there. Investigators, especially in recent years, have tried to determine their chemical composition. However, there are still some of these minerals which, familiar enough as regards their external characteristics, have never been subjected to a rigid chemical analysis. Of those specimens already examined, the analyses show too little agreement to justify a positive conclusion concerning their composition. It is for these reasons that I have investigated several of them.*

Petalite's Physical Properties

Arfwedson began his work in exemplary fashion by examining the physical properties of petalite. His ability is indicated by the fact that the value he determined for specific gravity is in good agreement with the present figure. The technology of the period can be glimpsed in his descriptions. It is the time of the tinderbox: with "striking steel," petalite produces sparks in abundance. This property may have been one of its chief virtues originally. Or, its occasional occurrence as a flesh-colored rock may have given it an added attraction as a decorative piece or paperweight.

➤ MYSTERY SCENE: *The mine at Utö is on an island which lies 2 miles from the Swedish mainland. It has been the scene of many mineralogical discoveries. None, perhaps, held more fascination than the specimen of ore discovered there by the Brizilian scientist Jose Bonifacio de Andrade Silva. It was many years before its mysteries were unlocked.*

(Photo courtesy of Lennart Af Petersens, Stockholm, Sweden)

PETALITE

Mr. d'Andrada has already described a mineral called petalite, found not only at Utö but also at the Finngrufva near New Kopparberg, and at Sala. However, since d'Andrada's petalite does not seem to be exactly like the mineral I have analyzed, I will give a detailed description of the petalite I found. (1)

Its color varies. Often it is milk-white. Occasionally it is rose approaching flesh color. It even occurs in a grass-green, possibly from an admixture of chlorites, similar to quartz. However, all colors other than milk-white are only fortuitous and are produced by foreign substances.

Petalite is never found crystallized, but only in an amorphous mass. It rarely occurs in pure form, except for some small pieces no larger than a few cubic inches. Ordinarily it is accompanied by quartz, feldspar, triphane (spodumene), tourmaline, and sometimes mica. (2)

On the surface it is lustrous in varying degrees — most frequently like mother-of-pearl. Inside and in a fresh break, its luster is like that of glass. This arises from its lamellate structure which is distinctly visible along an oblique break. The longitudinal break is lamellate. If the specimen is pure, the layers are all parallel and you can easily separate them, even ones measuring only one-twelfth of an inch or thinner. In less pure petalite, the layers are flaky, wavy and present a less definite appearance.

The transverse break, like that of quartz, is compact, rather bright, and at times somewhat splintery. If the specimen is split along the diagonal, the break appears irregular, sometimes twisted and sometimes stringy. This can be discovered most readily if the break is investigated at the edge or vertical to the thickness of the layers but parallel to their length.

➤ SUSPICIOUS: *A sample of ore, known as petalite, showed suspicious behavior when subjected to the critical eye of the detective, Arfwedson. Mineralogists, who had long been familiar with the physical properties of petalite, considered it a simple aluminum silicate containing potash and soda. Arfwedson thought otherwise.*

In small fragments petalite is visibly prismatic. The prisms are flat with more or less uneven edges and most frequently pointed at the ends. The mineral is perfectly transparent at the edges and in small fragments; less so, however, if the pieces are a half-inch thick or more.

It is quite hard and seems to resemble feldspar and triphane (spodumene) most closely. It is, however,

(1) NOTE: The superscripts, 1 to 12, throughout the article refer to Dr. Markowitz's comments on the Arfwedson translation on page 29.

We suggest that the commentary be read after the story — instead of concurrently with it.

not scratched by either one and does not scratch them. It can scratch glass easily. With striking steel it produces an abundance of sparks. It breaks easily in the longitudinal direction, less well transversely, if it is not penetrated, as frequently happens, by fine loose pieces which cut the layers vertically.

In a diagonal division — a most difficult thing to do — it is found to be hard and tough. Ground into powder, it becomes opaque and milk-white.

I have found its specific gravity to be 2.421.

It does not become electrified either from rubbing or heating.

Its refraction is simple, at least if the object viewed is placed against the flat side of the slab.

Under the blow-torch it melts almost as readily as adularia. You obtain a glass which at first is whitish. On further heating this becomes colorless with small bubbles of air trapped inside. (3)

With borax, it dissolves more readily than does feldspar, and the glass becomes clear and colorless.

Petalite is partly decomposed when it is digested with acids.

The original form of petalite is a rhomboidal prism in which the proportion between the two diagonals is as $\sqrt{13} : \sqrt{2}$. This ratio determines the size of the two opposite angles. The greater one is 137°8′; the smaller one, 42°52′. This prism can be divided along the shorter diagonal into two faces. Each face forms an isosceles triangle, and this comprises the integrating part.*

* Obtained and calculated by Abbé Haüy, the famous nineteenth century French mineralogist, with mechanical division and the aid of a gonimeter.

Blind Alley

Trouble began not long after Arfwedson got under way with his gravimetric analysis. He found that the mineral did not behave chemically according to the rules.

Running through a conventional test on two grams of petalite, he finished with a four percent loss that he could not account for.

The first phase of the analysis can be summarized as follows.

Arfwedson:

1. Fused petalite with potassium carbonate,
2. Determined the silica content,
3. Precipitated the alumina with ammonium carbonate,
4. Calculated his results, to find four percent of the original substance had disappeared.

I heated two grams of powdered petalite red hot in a platinum crucible over an alcohol flame. The loss of weight was only five milligrams; this can undoubtedly be attributed to moisture contenet.

(a) I triturated two grams of petalite, mixed the powder with six grams of basic potassium carbonate anhydrous, and exposed the mixture to a very hot flame for an hour. The resultant mass was fused and perfectly white. I dissolved it in muriatic acid, evaporated the solution to dryness and re-dissolved the residue in water containing a little of the same acid. There remained a pure white silica. I filtered this substance, washed it and dried it in the flame. It weighed 1.564 grams. (4)

(b) After having neutralized the acid liquor with ammonium hydrox-

iae. I poured some drops of ammonium oxalate in it. A little precipitate formed, probably calcium oxalate. However, it was present in too small an amount to be collected and weighed. I then precipitated the solution entirely with ammonium carbonate. (5) Filtering gave me a white and voluminous sediment. I washed this thoroughly with boiling water and dried it in the flame. It weighed 0.356 gram and had not changed color at all.

This substance dissolved in sulfuric acid. When it was combined with potassium sulfate (provided by the evaporation of potassium alum and the mother liquor), it yielded with pure caustic potash a precipitate that was entirely re-dissolved by an excess of the same alkali. (6) I concluded from this that the substance was simply alumina.

Finally, I boiled the wash waters that remained, but neither by this means nor with ordinary reagents could I extract any other substance from them. (7)

Here, then, is the result of the analysis:

	Grams	Parts per Hundred
Silica (a)	1.564	7.82
Alumina (b)	0.356	17.8
Lime	*A Trace*	..
Loss	0.080	4.0
	2.000	100.0

Arfwedson Follows a New Trail

Here is the setting and the *raison d'etre* for our chemical detective story. The "detective," while not yet alert to the true nature of the loss, suspects that he has encountered an unexpected unknown. His first trial having proved futile, he does not hesitate but, like the immortal Holmes, attacks the problem with skill and tenacity. The essential fascination of any mystery lies in the irresistible urge to solve it and Arfwedson was obviously well endowed with scientific curiosity.

The following steps essentially comprise phase two. In his second attempt, Arfwedson:

1. Decomposed the petalite with barium carbonate,
2. Removed the silica and alumina, and the barium sulfate obtained by adding excess sulfuric acid,
3. Evaporated the washings,
4. Volatilized the ammonium salts, sulfate,
5. Obtained a soluble, non-volatile
6. Attempted vainly to precipitate an aqueous solution of the salt with tartaric acid, "platina" solution, and caustic potash,
7. Concluded that the base could not be potash or magnesia,
8. Assumed that the salt was sodium sulfate,
9. Calculated his results on this basis. His analysis totaled 105 percent.

A loss of such magnitude could not occur in an analysis as simple as this one, unless a water-soluble substance in the mineral had escaped in the leach water. To verify this possibility, I repeated the analysis in another manner.

(a) I calcined two grams of very finely powdered petalite with eight grams of high purity barium carbonate in a platinum crucible for an hour and a half. This produced a white and compact but unfused mass. I treated this product with dilute muriatic acid in slight excess, evaporated it to dryness and re-dissolved it to assure myself that all the barium was dissolved. I obtained silica, which, washed thor-

oughly and dried in the flame, weighed 1.607 grams.

(b) Into the washwater from which the silica had been separated and which contained the barium chloride, I poured sulfuric acid until no more precipitate—barium sulfate—formed. (8) I filtered the solution and precipitate and washed the mass thoroughly with boiling water. I then saturated the solution with ammonium carbonate which gave me alumina completely free of silica. When this was washed, heated and dried it weighed 0.332 gram.

(c) The remaining liquids were evaporated to dryness; and the volatile salts, the ammonium sulfate and chloride, were driven off by heating. The saline residue dissolved in water and left only a small quantity of calcium sulfate undissolved. Naturally, this salt was a sulfate because in decomposing the barium chloride I had added sulfuric acid in excess. Since I wanted to ascertain its composition accurately, I knew I would have to neutralize it so that it contained no muriatic acid at all. Therefore, I added to it a quantity of ammonium sulfate suwcient for this purpose, evaporated the solution to dryness and heated the residue. The neutralized sulfate, fused, weighed 0.358 gram, and yielded the following analysis:

		Grams	*Parts per Hundred*
Silica	*(a)*	1.607	80.35
Alumina	*(b)*	0.332	16.60
Sulfate	*(c)*	0.358	17.90

But I still did not know the true composition of this salt. (9) Its solution was precipitated neither by tartaric acid in excess nor by platinum chloride. Consequently there was no potash in it. I mixed a part of the salt with some drops of pure potash but this did not make it clouded. Thus, there was no more magnesia in it. I reasoned that this ought to be a salt with soda base. I tried to calculate the amount of soda (sodium sulfate) that should be present in it. However, my calculations invariably gave me an excess of about 5% of the analyzed mineral.

The Quest Continues "With All Possible Care"

Arfwedson, revealing some distrust of the human factor, offered possible explanations for the untoward results: the materials were not washed thoroughly; the analysis was not made carefully enough. To eliminate all errors, he repeated the test two times "with all possible care" to wash his precipitates properly. Even so the unpremeditated deviation recurred.

Then, as it appeard a probability that the different substances were not well washed, or that the analysis was not made with enough precision, I repeated it twice again with all possible care. I got the same results each time.

I obtained:

The first time:

	100 parts
Silica	78.45
Alumina	17.20
Sulfate	19.50

The second time:

	100 parts	
Silica	79.85	
Alumina	17.30	
Sulfate	17.75	*(10)*

The Final Breakthrough

The dawn of enlightenment shone upon his work at last and he realized

that his recalcitrant test samples contained a substance whose identity he did not recognize. The search was over; the trail had led slowly but inevitably to the ultimate discovery. It remained only for Berzelius to name Arfwedson's new element.

Finally, after having studied most closely the sulfate in question, I found that it contained a particular fixed alkali, the nature of which was not yet known. Professor Berzelius proposed the name "lithion" for it (from the Greek word "lapideus"), because this alkali was first found in the mineral kingdom. (11, 12)

Epilogue

In 1818, about one year after his momentous discovery, Arfwedson reported his work "Investigation of some minerals from the Utö mine and the discovery of a new fixed alkali" in the Swedish scientific journal "Afhandlingar i Fysik, Kemi och Mineralogi." The article was soon translated and appeared in Germany in Dr. Schweigger's "Journal für Chemie und Physik" (1818) and in France in "Annales de Chemie et de Physique" (1819).

However, no other translations were ever published. Searches in the Library of Congress, the Union Library Catalog of Philadelphia, and the New York Public Library have failed to turn up any subsequent versions. The new translation was motivated by this lack and by the historical importance of Arfwedson's work.

The length of the original report made its verbatim reproduction in this issue impossible. However, a complete version of this little known chapter from the annals of science is available from Foote Mineral Company's Technical Literature Department.*

▸ THE FINAL CLUE: *The mystery was finally solved in the laboratories of the famous Swedish scientist, Berzelius. After months of meticulous investigation, Arfwedson brought the case to a close through a brilliant piece of deductive logic. The world now knows the mystery of the mine at Utö.*
(Photo courtesy of the Swedish Royal Academy of Sciences.)

In "Discovery of the Elements" (Sixth Edition), Mary Elvira Weeks has written a superb account of Arfwedson and his work. Chapter 18, "Three Alkali Metals" gives some interesting historical background on lithium, while Chapter 19, "J. A. Arfwedson and his Service to Chemistry" is a good concise biography of the man.

The fact that lithium's remarkable properties went unrecognized and unappreciated for over a century does not lessen the importance of Arfwedson's "find." In the history of chemistry, the discovery of lithium will remain an invaluable heritage of the nineteenth century to our own time and ages yet to come.

* 18 West Chelten Ave., Philadelphia 44, Pa.

COMMENTARY ON ARFWEDSON'S WORK

by Dr. Meyer Markowitz, *Senior Research Chemist, Research and Development Department, Foote Mineral Company*

1. These differences observed by Arfwedson must be taken as being merely superficial in nature.

2. It is well to mention at this point that the major lithium-bearing minerals are lepidolite or lithium mica $[(Li,K,Na)_2\ Al_2(SiO_3)_3\ (F,OH)_2]$, amblygonite $[(LiAlPO_4)]$, spodumene $[LiAl(SiO_3)_2]$ and the subject of the present paper, petalite, $[LiAl(Si_2O_5)_2]$. Petalite has a high lithia to alumina ratio and, accordingly, finds use as an inexpensive source of lithium for the glass and ceramics industries.

Because of the low atomic weight of lithium, it is readily seen that the weight percentage of lithium in any of these sources is quite low.

3. Modern studies of the thermochemical behavior of petalite have shown that the irreversible dissociation of the material into a solid solution of silica in beta spodumene provides the basis for the utilization of petalite in ceramic compositions of high thermal shock resistance.

4. This procedure, of course, brings about solubilization of the alumina and silica contents through conversion to aluminates and silicates. Upon the addition of acid, silica precipitates; lithium carbonate and the aluminate compounds go into solution.

5. Through the fortunate choice of a small sample size, lithium carbonate did not precipitate. Arfwedson subsequently recognized the relative insolubility of lithium carbonate as distinguishing the new element from the other alkali metals. The kinship of lithium to both the alkali metals and the alkaline earth metals is well known now.

6. Solution of aluminum hydroxide occurs through the formation of aluminate ions (AlO_2^-).

7. It is through the sequence of operations conducted in this section (b), that the lithium values of the petalite were lost. Concentration of these wash liquors and addition of ammoniacal solutions of ammonium fluoride, ammonium carbonate, or of a soluble phosphate would have produced precipitates of the corresponding lithium fluoride, carbonate, or tertiary phosphate, respectively. However, this is but another instanc of hindsight being easier than foresight.

8. In this manner, the added barium can be removed to yield a separation of only the components of the petalite.

9. It is intersting to note that there are two gravimetric procedures commonly used for the quantitative determination of lithius, vis., conversion to lithium sulfate, and to lithium chloride. Modern procedures are based on flame photometry utilizing the intense crimson emission line at 6703 A. This provides the most rapid and convenient means for analysis, avoiding troublesome separation from the other alkali metals,

10. The three sets of results reported give the following mole ratios of

$SiO_2:Al_2O_3:Li_2O$, 8.22 : 1.00 : 1.00, 7.74 : 1.00 : 1.05, and 8.23 : 1.05 : 1.08, which compare quite favorably to the theoretical ratio of 8 : 1 : 1. A present-day, detailed analysis of petalite would correspond closely to: 76.16% SiO_2, 17.24% Al_2O_3, 4.49% Li_2O, 0.18% Fe_2O_3, 0.39% K_2O, 0.16% Na_2O, 0.24% MgO, 0.21% CaO, 0.11% F, and 0.80% ignition loss.

11. Evidently the reference here is to sodium and potassium which had been isolated electrolytically not too long previously by Sir Humphrey Davy (1778-1829).

12. Arfwedson's contributions to lithium chemistry extend to the discovery of lithium in spodumene, and the preparation and characterization of a number of lithium compounds, e. g., lithium acetate, chloride, nitrate, borate, hydroxid, tartrate, etc. His attempts to isolate lithium metal were unsuccessful because of the nonavailability of a sufficiently powerful source of electricity. R. Bunsen and A. Matthiessen were able to prepare lithium metal electrolytically in 1855 in sufficient quantity to allow for its characterization.

Small Radiation Doses Measured Chemically

➤ EXTREMELY small radiation dosages can be measured with a special luminescent powder that gives off light when it is heated, researchers at the U. S. Naval Research Laboratory in Washington have found.

The chemical used is a phosphor which stores energy while it is being irradiated. The energy is later released by thermoluminescence, in which the energy is given off as light when the temperature of the substance increases.

The amount of light given off is determined by the amount of radiation that has been received.

The material has been used in rocket experiments to measure the tiny amounts of ultraviolet rays and X-rays encountered in the atmosphere, Dr. Herbert Friedman of the Laboratory told Science Service.

The substance, calcium sulfate-manganese, is much more sensitive than the material now used in monitoring badges worn by workers exposed to radiation. The lower limits of sensitivity for most personnel dosimeters is in the region of one to 100 roentgens of radiation. The phosphor, however, measured a minimum dose of ten thousandths of a roentgen and calculations indicated that it could go even lower than this.

A practical difficulty with the material is that the amount of light given off decreases with time after the exposure. There is about a 40% loss after the first eight to ten hours, Dr. Friedman said.

The difficulty can be overcome, however, if the exposure time is known, since the amount of decay is proportional and a correction can be made for it.

The chemical has already been used by other researchers to study the ultraviolet emission of the sun and to determine the dosage of medical X-rays. Dr. Friedman co-authored a report on the research with Dr. David A. Patterson, also of the Laboratory, in the December Journal of the Optical Society of America.

Ocean Floor Rise Measured Chemically

➤ Scientists in Bombay have developed a chemical process for measuring the rate at which the floor of the Pacific Ocean is building up.

Chemical extraction of a radioactive isotope of beryllium from a 49-foot core drilled from the floor of the Pacific indicates dirt, sand, dead marine life and other sediment are building up new floor at a rate of about 18 hundredths (0.18) of an inch every 1,000 years.

The work, reported in Deep-Sea Research, is based on the known decrease in activity of the long lived beryllium-10 isotope, with a half-life of 2,700,000 years. The isotope, produced by cosmic ray action, is believed to have been precipitated for millions of years with rain water. The scientists assumed the precipitation to have been unvarying, and assumed the core under study represented sediment that had been undisturbed for millions of years.

Chemical extraction of the isotope selected at measured depths on the core gave samples of the radioactive isotope from which it was possible to determine the age of the sediment at a particular depth.

Movie Projector Duplicates Sun's Heat

➤ Ordinary movie projection equipment has been used to produce temperatures approaching that of the sun's surface by scientists at the National Carbon Company, Parma, Ohio.

Highly polished curved mirrors concentrate rays from a carbon arc into the beam that raises temperatures of materials placed in the focal point to more than 7,000 degrees Fahrenheit.

Although the arc image furnace is not new, Dr. R. G. Breckenridge, director of the company's research laboratories, said the use of two elliptical mirrors rather than parabolic ones made reaching such high temperatures possible.

One mirror directs the arc's energy at the other, which in turn concentrates the radiation on the specimen being heated. The high temperatures are thus obtained without any contamination of the sample, Dr. Breckenridge said.

The new equipment is highly compact and portable. It is said to produce results comparable to those of solar furnaces having a 60-inch diameter reflector.

Two entirely new uses of lead are the "mighty midget" battery for miniature electronic circuits and leaded ceramic colors on one face of glass building blocks.

World consumption of fossil fuels has been more than 2,500,000,000 tons per year.

Science Talent Search Top Forty Picked

➤ THE 40 MOST promising research scientists in America's high schools have been selected in the 17th Annual Science Talent Search. The winners, eight girls and 32 boys, have been invited to Washington for a five-day, all-expense-paid visit Feb. 27 through March 3.

They will participate in the Science Talent Institute and compete for $34,250 in Westinghouse Science Scholarships and Awards in the finals of the Science Talent Search conducted by Science Service.

The 40 trip winners (see following list), 15 to 18 years of age, were chosen by a panel of judges after a nation-wide competition in which top-ranking seniors in all the public, parochial and private schools in the continental United States were invited to participate. Contestants, representing 47 states and the District of Columbia, completed the stiff science aptitude examination, submitted recommendations, and scholarship records, and wrote a report on "My Scientific Project."

During the past 17 years 249,955 high school seniors have entered the Search. Of this number only 48,098 have been able to complete all the requirements. This year, of the 25,039 examinations sent to 3,298 high school educators, only 4,050 students cleared all the hurdles to qualify for the Search.

Of these, 1,074 scored high enough on the aptitude test to be named Candidates. The 40 winners and 260 honorable mentions were then chosen from the Candidate group.

Top Award is $7,500

On March 3 at the end of the Science Talent Institute the judges will make the awards. Five winners will be selected to receive one of the following: $7,500, $6,000, $5,000, $4,000, $3,000 in four-year Westinghouse Science Scholarships. A total of $8,750 in Westinghouse Science Awards will be given at the discretion of the judges to the other 35 winners.

Chosen without regard to geographic distribution, the 40 trip winners come from 35 cities in 19 states and the District of Columbia. States represented by winners since the beginning of the Search in 1942 now total 43.

Most Are Top Students

All but one of the winners live at home and attend their local or nearby public, parochial or private secondary schools.

A check shows that 32 of the students are in top five percent of their graduating classes and 20 of them rank first, second or third. Classes range in size from 29 to 1,243 seniors. Exactly 70% of the winners' fathers and 50% of their mothers attended college. Of the winners, 23 claim no scientists among their relatives; the others have one or more scientists in their families.

Contrary to a frequent notion about scientists, these talented young people do not confine their interest and enthusiasm to science. While most of them spend much of their spare time in activities such as science clubs and individual science hobbies they also enjoy such varied interests as photo-

graphy, music, sports, reading and creative writing. Most of them belong to extra-curricular, social and educational organizations and more than half of them have held office in these clubs. Five of them have been finalists in the National Science Fair.

Careers Are Planned

All of the top 40 already have chosen the lines of study they wish to pursue. Fourteen plan to become physicists. Six hope to be engineers; five are headed for careers in biochemistry and five in mathematics. Chemistry is the final choice for three and two hope to be physicians. One each is planning to be an astronomer, biologist, psychiatrist, zoologist. One refuses to commit himself further than to say he will be a scientist. All expect to do research in their respective fields.

Only two high schools in the U. S. have produced more than one winner this year. Jamaica (N. Y.) High School and Newton High School of Newtonville, Mass., will each send two boys to the Science Talent Institute.

Among the 40 a total of 25 come from schools that have never before placed a winner in the Science Talent Search. The other 15 are adding new laurels to schools already honored in the past by having produced winners. Each school having a winner receives a bronze and walnut plaque to add to the school's trophy collection.

With a 17-year total of 19 winners, Bronx High School of Science in New York City leads previously honored schools who have additional winners this year. Only one school, with a total of 21, has had a larger roster of winners.

In the 17 years of the Search Erasmus Hall High School, Brooklyn, N. Y., has produced 11 winners. Newton High School, Newtonville, Mass., and Kenmore (N. Y.) Senior High School are each credited with five winners. The following have had four winners each: University High School, Bloomington, Ind., Phillips Academy, Andover, Mass., and Columbus High School, Marshfield, Wis. Three winners have been produced over the years by Lyons Township High School, La Grange, Ill., and Central High School, Omaha, Nebr.

The following schools now have a record of two winners for the 17 years of the Search: El Cerrito (Calif.) High School, Tamalpais High School, Mill Valley, Calif., Anacostia High School, Washington, D. C., Ithaca (N. Y.) High School, and Overbrook High School, Philadelphia, Pa.

In addition to the 40 trip winners, who will attend the Science Talent Institute in Washington, an Honorable Mentions list of 260 in this year's Search will be recommended to colleges and universities for their aptitude in science. All 300 will receive offers of scholarships from many institutions of higher education seeking students with talent in science.

Through an arrangement with Science Clubs of America, 31 states and the District of Columbia are conducting state Science Talent Searches concurrently with the national competition. Thirteen of them have produced winners this year. In these 32 areas all entries in the National Science Talent Search will be turned over to state judging committees. From their entries they will choose state winners and award scholarships to various colleges and universities

within the state. Cooperating states are: Alabama, Arkansas, Connecticut, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nebraska, New Hampshire, New Mexico, North Carolina, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, West Virginia and Wisconsin.

The Westinghouse Educational Foundation, supported by the Westinghouse Electric Corporation, provides the scholarships and awards and makes the Science Talent Search financially possible as a contribution to the advancement of science in America.

Conducted Through SCA

The annual Science Talent Search is conducted by Science Clubs of America, administered by Science Service. Science Clubs of America is the international organization for science groups in schools and out. Today more than 17,000 clubs are affiliated here and abroad, with a membership of almost a half million young people.

The other annual event, conducted by Science Clubs of America, is the National Science Fair which will be held in Flint, Mich., May 7 through 10, 1958. Twenty-three of the Science Talent Search Candidates this year have been finalists in recent National Science Fairs.

Judges for the Science Talent Search, who selected the winners, are Dr. Harold A. Edgerton, vice president of Richardson, Bellows, Henry & Co., New York; Dr. Steuart Henderson Britt of Northwestern University, Evanston, Ill.; and Dr. Rex E. Buxton, psychiatrist of Washington, D. C. Drs. Edgerton and Britt design the Science Aptitude Examination each year for the Science Talent Search.

The following list of Science Talent Search Winners and Honorable Mentions is presented as an indication of the geographical spread of the Search and the scope of projects performed. The project reports have not been published. Some will appear occasionally in CHEMISTRY. Eight previous reports were published in CHEMISTRY, September, 1957 (copies of that issue available at 50¢ each), and one report was published in CHEMISTRY, January, 1958.

Washington Trip Winners

* indicates girls — HOME ADDRESS follows name of school

H. S. indicates High School — AGE of winner follows name

TITLE OF PROJECT REPORT follows Home Address

ALABAMA

Montgomery — Shepard, Kenneth Wayne (17) Sidney Lanier H. S. 3854 Maclamar Rd. Vortexes in Liquids Draining from Tanks

ARIZONA

Tucson — Jensen, Richard Joseph (16) Salpointe H. S. 5602 E. Silver St. Determination of Integral Pythagorean Numbers

CALIFORNIA

Albany — Kirk, Rodney Carlos (17) Albany H. S. 904 Evelyn St. 6 – Construction and Operation of a Pulse Height Analyzing Scintillation Counter

El Cerrito — Williams, Robley Cook, Jr. 17 El Cerrito H. S. 1 Arlington Ct., Berkeley 7 – Experiments with Algae

Los Angeles	Kukla, Andy (16) Fairfax H. S. 8409 Blackburn Ave. 48 – Geometry of Panangular, Complex, Inverse, and Complex Inverse Polygons
Mill Valley	Nininger, Neil Logan (18) Tamalpais H. S. 24 Liberty St., Larkspur Production of High Temperature Tantalum Carbide Filaments
	DISTRICT OF COLUMBIA
Washington	Rice, Jerry Mercer (17) Anacostia H. S. 161 Chesapeake St., S.W. 24 Effect of a Chemical Carcinogen upon Malignant Cells Cultivated in Vitro
	Devine, Paul Joseph, Jr. (17) Gonzaga H. S. 6157 12th St. N., Arlington 5, Va. – A Theory of Quantum Electrodynamics
	FLORIDA
Miami Beach	Pestcoe, Allan Emanuel (17) Miami Beach Senior H. S. 6375 Indian Creek Dr. 41 – Experiments with Plants Done in a High School Radioisotope Laboratory
	ILLINOIS
Chicago	*Londak, Bernadette Genevieve (17) Mercy H. S. 7749 S. Langley Ave. 19 Geometric Proof of Kepler's Second Law
Dupo	Dyroff, David Ray (17) Dupo Community H. S. Box 275 An Original Electronic Vector Computer
Franklin Park	Jerina, Donald Michael (18) Leyden Community H. S. 2427 N. Clinton St., River Grove – Aromatic Amino, Azo, and Carbonyl Compounds
La Grange	Gentle, Kenneth William (17) Lyons Township H. S. 843 Homestead Rd. Relationship Between Cosmic Radiation and Sunspot Activity
	INDIANA
Bloomington	Martz, Eric (17) University H. S. 817 Atwater Ave. – Effect of a Dentifrice Containing Sodium Lauryl Sulphate on the Oral Lactobacilli Count
	IOWA
Charles City	Martens, Charles Paul (17) Charles City H. S. Route 4 Research on the Radial System of Venus
	MARYLAND
Baltimore	Gaidis, James Michael (17) Baltimore City College 1511 Carswell St. 18 Development of Transistorized Communicators
	MASSACHUSETTS
Andover	Weihofen, William Henry (17) Phillips Academy 908 Avenida Cielito, N. E., Albuquerque, N. Mex. Topological Analysis by Mean of Dual Maps
Attleboro	Thomae, Irving Herbert (17) Attleboro H. S. 123 Berwick Rd. Effect of Pole Piece Formation on Magnetic Lens Efficiency
Newtonville	Beeuwkes, Reinier III (17) Newton H. S. 123 Sargent St., Newton 58 Design and Construction of an Electron Cyclotron
	Mitrovich, Dushan (18) Newton H. S. 105 Waban Hill Rd., Chestnut Hill 67 – Flight and Stability Studies of a Model Shrouded-Propeller-Type Flying Platform
	MICHIGAN
Romeo	Burns, Stephen Kent (17) Romeo H. S. 147 Church St. Color Television Using a Single Vidicon-Type Camera Tube
	MONTANA
Choteau	Malone, Jesse, Jr. (17) Choteau H. S. Route 2 Insects in My Life
	NEBRASKA
Omaha	Kripke, Saul Aaron (17) Central H. S. 119 N. Happy Hollow Blvd. 32 The System LE^1
	NEW JERSEY
Elizabeth	Seaton, Robert Kirk (17) Thomas Jefferson H. S. 25 Scotland Rd. 3 A Solar-Heated Greenhouse
Teaneck	*Shelby, Jane (17) Teaneck H. S. 431 Claremont Ave. – Calculation of the Orbit of Satellite 1957 Alpha$_1$ from Amateur Observations
	NEW YORK
Brooklyn	Kapular, Alan Mitchell (15) Erasmus Hall H. S. 47 E. 16 St. 26 Effects of Colchicine upon Orchid Plant Genetics
	Halperin, Bertrand Israel (16) George W. Wingate H. S. 7 Balfour Pl. 25 Solution of a Famous 8-Color Problem and Its Generalizations

Ithaca

Cantrell, Cyrus Duncan III (17) Ithaca H. S. 228 S. Geneva St. Optics of the Ellipse with Emphasis on Parallel Incident Rays

Jamaica

Burger, Richard Melton (16) Jamaica H. S. 21-15 34 Ave., Long Island City 6 — A Time Lapse Photographic Study of the Reaction of Drosera Internedia (Sundew) to Certain Chemical and Physical Stimuli

Wagreich, Philip Donald (16) Jamaica H. S. 67-47 182 St., Flushing 65 Development of Resistance to Bacteriophage in Escherichia Coli

Kenmore

Okun, Lawrence Merritt (17) Kenmore Senior H. S. 259 Hartford Ave. 23 A Study of Ascites Tumors

New York

Kuzmack, Arnold Mark (16) Bronx H. S. of Science 37-22 95 St., Jackson Heights 72 — Behavior of the Gamma Function for Very Small Values of the Argument

*Herschkopf, Sybil (17) Ramaz H. S. 638 W. 160 St. 32 — Effects of Terramycin and Gibberellic Acid on the Growth of Bean Plants

Yonkers

Rosner, Jonathan Lincoln (16) Roosevelt H. S. 300 Hollywood Ave., Tuckahoe 7 — Degeneration and Regeneration of the Sciatic Nerve in the Mouse

OHIO

Vermilion

Smith, Leslie Ewart (17) Vermilion H. S. 39 Huron Rd. Comparison of Solid Propellants with Particular Attention to Their Use in Small, Unmanned Rockets

OREGON

Corvallis

*Marshall, Ruth Ann (17) Corvallis Senior H. S. 302 N. 21st St. Study of Protozoa

PENNSYLVANIA

Philadelphia

*Erlich, Elvera Rena (15) Overbrook H. S. 5648 Diamond St. 31 New Discovery in the Decomposition of Ammonium Dichromate

Upper Darby

*Waldman, Lise Jo (16) Upper Darby Senior H. S. 625 South Ave., Secane — Determination of the Atmospheric Mass Absorption Coefficient in Three Portions of the Solar Spectrum

WISCONSIN

Marshfield

*Karau, Jane Ruth (17) Columbus H. S. 510 W. 6th St. Natural Dyes for Home Use

WYOMING

Cheyenne

*Wallace, Lynda Diane (17) Saint Mary H. S. 3421 Dover Rd. Tentative Identification and Further Studies on an Unknown Bacterium

Honorable Mentions

* indicates girls — HOME ADDRESS follows name of school

H. S. indicates High School — AGE of winner follows name

TITLE OF PROJECT REPORT follows Home Address

ALABAMA

Decatur

Marshall, James Lawrence (17) Decatur H. S. 819 8th Ave., S.E. Effects of an Electromagnetic Field on Metals

Tuscaloosa

Tunstall, Brian Parker (17) Tuscaloosa H. S. 514 Capstone Ct. Rocketry

ARIZONA

Phoenix

Fogle, Thomas Franklin (17) Camelback H. S. 2424 E. Avalon Dr. A Two-Year Study of Thunderstorms

Cords, Donald Philip (17) North Phoenix H. S. 5141 N. 18th Pl. Effect of Selected Wave-Lengths of Light on the Growth of Scenedesmus Obliques and Chlorella

Farnbach, William Adolph (17) North Phoenix H. S. 536 E. Cherry Lynn Rd. — An Audio Amplifier Based on the Wheatstone Bridge

Turner, Gary Burgess (17) North Phoenix H. S. 825 E. Lawrence Rd. Relationship of Rate of Transfer of Heat Between Liquids to Their Relative Specific Heats

*Farone, Barbara Helene (17) West H. S. 3413 N. 16th Dr. Effect of Electrostatic and Magnetic Fields on the Ionization of Gases

*Gates, Prudence Ann (17) West H. S. 317 W. Encanto Blvd. Metabolism of the White Rat

	Gollub, Michael H. (17) West H. S. 3106 N. 15th Ave. Electrolytic Ion Amplifier
	Lipschultz, Allen Seymour (17) West H. S. 4204 N. 18th Ave. – Determination of the Morphology of the Erythrocyte in Selected Anemias
	Schmieder, Robert William (16) West H. S. 6012 N. 2nd Ave. Construction of an Electronic Clock
	Ulinger, Peter Craig (17) West H. S. 2814 N. 11th Ave. Electrical Muscle Stimulation
	Warrenburg, Wallace Robert (17) West H. S. 5835 N. 2nd Ave. Building an Analog Computer

ARKANSAS

Little Rock	*Oakes, Glennys Ann (17) Central H. S. 1 Ranch Valley Rd. Effect of an Inhibitor of Vitamin B$_6$ on Growth and Feather Development in the Chick Embryo

CALIFORNIA

Fresno	Tan, Henry (17) Roosevelt H. S. 1230 E. Swift St. 3 Building a Cyclotron
Gardena	Speltz, Peter Gregory (16) Serra H. S. 15812 Casimir St. – Analysis of Performance and Efficiency of a Small Four-Cycle Gasoline Engine
Los Angeles	Anderson, James Alfred (17) University H. S. 12427 Rochedale Lane 49 Properties of Some Complex Equations in Four Variables
Pasadena	Ulfeldt, Stanley Richard (17) John Muir H. S. 5415 Palm Dr., La Canada Ecological Study of the Rodents of the Chaparral
Pleasant Hill	Scott, James Lovell (17) Pleasant Hill H. S. 447 Cumberland Dr., Walnut Creek – Performance of Slits in Airplane Wings
San Francisco	*Cronander, Charlotte Diane (17) G. Washington H. S. 375 10th Ave. 18 Solar Energy: Practical Applications
	Woo, James Wing-Fai (16) Lowell H. S. 498 Funston Ave. 18 Resonance Energies of Two Imaginary Molecules
Santa Cruz	Bell, Lon Edward (17) Santa Cruz H. S. 722 Walnut Ave. Working on Solid Rocket Fuels
Vista	Matson, Clive Randolph (16) Vista H. S. 1954 Camino Loma Verde Angular Variation: An Experiment in the Refractive Indices of Crystals

CONNECTICUT

Westport	Wunsch, Carl Isaac (16) Staples H. S. 24 Compo Parkway Chelate Metal Complexes

DISTRICT OF COLUMBIA

Washington	Breed, Lawrence Moser (17) Sidwell Friends School 5001 30th St. N., Arlington 7, Va. – Measuring the Force of Compression of Monolayers of Various Hydrocarbons
	*Clarenbach, Lois Elinor (17) Sidwell Friends School 7113 Exfair Rd., Bethesda 14, Md. – Paths on a Lattice
	Lynn, Robert Walker (16) Woodrow Wilson H. S. 2935 Northampton St. N.W. 15 – Rate of Melanin Turnover in Tadpoles

FLORIDA

Fernandina Beach	Digby, Thomas Graham (18) Fernandina Beach H. S. 1620 Beech St., Box 304 – Building an Oscilloscope
Marianna	Janes, John Egbert (17) Marianna H. S. 525 Guyton St. – Slide-rule to Simplify the Mathematical Work of Nuclear Emulsion Determinations
Miami Beach	Preger, Robert Lawrence (17) Miami Beach Sr. H. S. 9072 Carlyle Ave., Surfside – Problems Encountered in Grinding a Ten-Inch Mirror for a Telescope

ILLINOIS

Arlington Heights	Knopp, James Arthur (17) Arlington Heights Twp. H. S. 521 S. State Rd. Experimenting with Sugar Plastics
Calumet City	*Stanich, Gloria Jean (16) Thornton Fractional Twp. H. S. 916 Wentworth Ave. – Experiments with Drosophila
Chicago	Kaplan, Myron Michael (16) Sullivan H. S. 2736 W. Sherwin Ave. 45 Experiments with the Geiger Counter
Edwardsville	*Dean, Helen Louise (17) Edwardsville H. S. 404 N. Buchanan St. Tranquilizers and Audiogenic Seizures in the A/Jax Mouse
Evanston	*Aslanian, Sara (17) Evanston Twp. H. S. 536 Custer Ave. Investigation and Development of Unusual Ceramic Glazes

	Douglas, Aaron Jack (17) Evanston Twp. H. S. 2122 Ashland St. Experimental Growth of Metal Whiskers
	•Hahne, Marjorie Helen (16) Evanston Twp. H. S. 2246 Ridge Ave. A Statistical Analysis of Fossil Species
	•Miner, Anne Story (17) Evanston Twp. H. S. 415 Dempster St. An Investigation of Some Aspects of TV-Instruction
La Grange	•Innes, Bette Jeanne (17) Lyons Twp. H. S. 239 S. 7th Ave. Iron Content of the Blood
	•Mertes, Janet Louise (17) Lyons Twp. H. S. 4514 Franklin Ave., Western Springs — What is Paint?
	•Rose, Nell Freda (17) Lyons Twp. H. S. 143 S. Edgewood St. Development of a Feed Ingredient from Packing House Blood and Manure Waste
	•Swanson, Linda Anne (16) Lyons Twp. H. S. 4548 Woodland Ave., Western Springs — The Crystallographic Lattice
Northbrook	Ledvinka, James David (17) Glenbrook H. S. 1420 Linden Dr. Experimentation with Henri Moissan's Diamond Synthesis Principles
Peoria	Brayton, Larry Ray (17) Richwoods Community H. S. 905 E. Glen St., Peoria Heights 4 — Design and Construction of an Ion Type X-ray Machine
Robinson	McIntosh, Patrick Siler (17) Robinson H. S. R. R. No. 2, Box 231 Solar Terrestrial Relationships and Selenography
Urbana	Bardeen, William Allen (16) University H. S. 55 Greencroft St., Champaign — Flow of Color Centers in KBr Crystals

INDIANA

Fort Wayne	Swinehart, David Parmer (17) Central Catholic H. S. 5115 Fairfield Ave. 8 — Oscillation of Ionic Gases
Hammond	Chappelie, Norman Andrew (17) Hammond H. S. 6925 Jackson Ave. Testing Rocket Motor Designs
	•Vergin, Marcia Ann (17) Hammond H. S. 8315 Greenwood St., Munster Effectiveness of Various Antiseptics on Different Kinds of Bacteria
Indianapolis	•Freeman, Julia Berg (17) Thomas Carr Howe H. S. 5461 Julian Ave. 19 Carcinogenically Induced Cancer in Mice
Michigan City	Hess, Charles Thomas (17) Elston Sr. H. S. 103 Schofield Ct. A 50,000 Volt X-ray Machine from Junk Yard Parts
Portland	•Settle, Eileen Jane (17) Portland Wayne Twp. H. S. R. R. No. 1, Keystone — Insects on 160 Acres
South Bend	Hobbs, Arthur Marmaduke (17) John Adams H. S. 1329 E. Monroe St. 15 Rotors, with Reference to the Minimum Area Problem
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	•Metcalf, Kathleen Patricia (16) St. Joseph Academy R. R. No. 2 Fertilizers, the Key to Better Crops
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Johnston	Leffler, Allan Theodore II (17) Johnston Cons. H. S. 6010 Otto Rd. Improvements in Receiver Construction
Orange City	Duven, Dennis James (17) Orange City H. S. 217 N. Da Costa St. An Electronic Speed Control for Model Trains

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	•Young, Deborah Louise (17) Lawrence H. S. 3 Westwood Rd. Effects of Cold on the Thyroid and Adrenal Glands of the Guinea Pig
Topeka	•Glendening, Ruth Ann (17) Topeka H. S. 1217 Mulvane St. Physiological Effects of Heat and Cold on Different Animals
	Hiebert, John Blake (17) Topeka H. S. 1517 Randolph St. A Method for Determining Vascular Union in Parabiotic Rats
	•Owen, Judith Charlene (17) Topeka H. S. 1320 Mulvane St. Precipitation of Blood Proteins

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Louisville — Blanford, George Emmanuel, Jr. (17) St. Xavier H. S. 2227 Millvale Rd. 5 – A Spectrophotometric Analysis of Indicators

LOUISIANA

Baton Rouge — Terrebonne, Robert Alexis (17) Baton Rouge Sr. H. S. 727 W. McKinley St. 2 – Model and Mathematics of the Vanguard Rocket

New Orleans — Mallerich, Dallas John, Jr. (17) Holy Cross H. S. 405 Norton St., Arabi Design and Construction of a Variable Frequency Oscillator

Shreveport — Caine, Stephen Howard (16) C. E. Byrd H. S. 3823 Creswell Ave. Design of a Corrosion Control Demonstrator

Phillips, Richard Earl (17) C. E. Byrd H. S. 118 E. Elmwood St. Experimenting with High Fidelity

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Shear, Jonathan (17) Bethesda-Chevy Chase H. S. 5203 Battery Lane 14 Mutations Induced in Escherichia Coli by the Antimetabolite 5-fluorouracfl

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South Hamilton — Woods, Gary Condie (17) Hamilton H. S. 57 Lois St. A Simple Light Beam Communication Outfit

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Flint — Cheney, George Eugene (18) Central H. S. 2211 S. Dort Hwy. 7 Design and Construction of an Analog Computer

Horner, Jack Allen (18) Flint Technical H. S. 3305 Herrick St. 3 Determination of Avogadro's and Boltzmann's Constants

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MINNESOTA

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St. Louis Park — Fackler, Orrin Dean (17) St. Louis Park H. S. 2604 Inglewood Ave. 16
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Mercurio, James Peter (17) Christian Brothers College H. S. 7208 Dorset St., University City 5 – Effect of Heat on Electrical Resistance

MONTANA

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Shelby — Lingerfelt, Garry Frank (17) Shelby H. S. 210 1st Ave. S., Box 733
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*Mills, Donna Mae (16) Brownell Hall 1000 Aldrich Rd., Lincoln 10
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New Brunswick — Williams, Robert Bruce (17) New Brunswick H. S. 34 Hill St., Milltown
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Conrad, Richard Henry (16) Rutgers Prep. School 240 S. Adelaide Ave., Highland Park – Euglena, Plant or Animal?

Princeton — Hoyler, Robert Clement (17) Princeton H. S. 183 Hamilton Ave.
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Union — Ullman, Neil Richard (17) Union H. S. 298 Newark Ave.
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NEW MEXICO

Los Alamos — Benson, David Bernard (17) Los Alamos H. S. 2314-B 35th St.
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Santa Fe — Brennard, Daniel Ponder (17) Santa Fe H. S. Box 1706 Zia Rd.
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NEW YORK

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*Jablonsky, Susan (17) Fort Hamilton H. S. 351 Marine Ave. 9
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Ithaca	Agnew, Palmer Wright (17) Ithaca H. S. 416 Highland Rd. – Design, Development, and Construction of a Small Binary Digital Computer
Jamaica	Fetterman, Harold Ralph (17) Jamaica H. S. 85-65 152nd St. 32 An Investigation of the Effects of Auxin on Plants
	Meltzer, David (15) Jamaica H. S. 88-18 178th St. 32 – Determination of the Dielectric Constant of Water in Its Solids and Liquid Phases
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Mamaroneck	Hanson, Kenneth Merrill (17) F. E. Bellows H. S. 203 Carroll Ave. Design, Construction and Application of a Low-Cost Precision Electronic Analog Computer
Mineola	Greenberg, Stephen Daniel (16) Mineola H. S. 20 Weybridge Rd. Design, Construction and Uses of a Six-Inch Cyclotron
New Rochelle	Clark, Richard Lee (17) New Rochelle H. S. 131 Rose Hill Ave. Crystals: Their Formation, Structure, and Classification
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Palmyra — Ferguson, Rolfe Pratt (17) Palmyra-Macedon Central School 20 Canandaigua Rd.
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Queens Village — *Bender, Linda Joan (16) Martin Van Buren H. S. 82-38 212th St. 27
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Tenenbaum, Joel (17) Martin Van Buren H. S. 86-06 208th St. 27
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Collins, Kenneth Alan (15) Martin Van Buren H. S. 73-30 Springfield Blvd., Bayside 64 – A Successful Laboratory Procedure for Obtaining Metallic Lithium

Rockville Centre — Krieger, Allen Stephen (16) South Side H. S. 243 Princeton Rd.
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Rome — *Gallivan, Mary Ellen (17) Academy of the Holy Names 705 Elm St.
Comparative Study of the Effects of Various Nutritives on Certain Bryophytes

Rye — Grave, Gilman Drew (17) Rye H. S. 594 Forest Ave.
Statistical Approach to Endocrine Relationships in Mice

Schenectady — Mead, Robert Mosher (17) Mont Pleasant H. S. 901 Union St. 8
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Springville — *Burnham, Mary Clare (17) Griffith Institute and Central School 56 Newman St. – The Effects of Estrogen and of Testosterone on the Skeleton of the C_{57} Mouse

Staten Island — Reiskind, Jeremy (17) Curtis H. S. 610 Victory Blvd. 1
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Syracuse — *Parisi, Lucy Florence (17) Eastwood H. S. 520 Hawley Ave. 3
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*Pekurney, Martha Carol (17) Eastwood H. S. 155 Plymouth Dr. 6
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Yonkers — Torop, Paul (17) Roosevelt H. S. 113 Cresthill Rd.
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NORTH CAROLINA

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Raleigh — Tripp, Alton Parker, Jr. (17) Broughton H. S. 2217 Creston Rd.
Building a Spectroscope

NORTH DAKOTA

Devils Lake — Thompson, David Allen (17) Central H. S. 724 Fifth St.
Designing and Testing Rockets

OHIO

Archbold — Stutzman, Kriss Leroy (17) Archbold H. S. Route 1
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Cleveland — *Manak, Barbara Rose (16) Lourdes Academy 2217 Montclair 9
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Dayton — Hacker, Richard McLean (17) Roosevelt H. S. 350 Verona Rd. 17
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Ponca City	Waters, Frank Clement Hugh (17) Ponca City Sr. H. S. 411 Drake Dr. A Demonstration of the Photoelastic Effect
Tulsa	Moran, William Preston (17) Cascia Hall Prep. School 2419 S. St. Louis St. 14 – Research in System Engineering

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	*Brady, Mary Ann (16) Corvallis Sr. H. S. 403 Whiteside Dr. Construction of a Cuprous Oxide Photocell
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Portland	Ashley, Roger Parkmand (17) Lincoln H. S. 4837 W. Burnside Rd. 1 Construction of a Differential Thermal Analysis Apparatus for Qualitative Determination of Thermally Active Minerals
	*Munson, Edith Linda (17) U. S. Grant H. S. 4072 N. E. 32nd Ave. 12 Duplication of C. M. Hall's Patents for Production of Aluminum from Aluminum Oxide

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Elkins Park	Kreuzer, Lloyd Barton (17) Cheltenham H. S. 325 Harrison Ave. 17 Relation of Erythropoietin to Hereditary Macrocytic Anemia in the House Mouse
Kingston	Lewis, Daniel Evan (17) Kingston H. S. 387 Tioga Ave. – An Application of the Calculus of Variations: The Brachistochrone Problem
McKees Rocks	Desiderio, Dominic Morse, Jr. (17) Stow H. S. 1301 Woodward Ave. A Model to Illustrate Molecular Action
Millersburg	Stetz, Albert William (18) Millersburg-Upper Paxton Union H. S. 640 State St. – Designing and Building Experimental Sonar
Moylan	*Kiefer, Nancy Winona (17) Notre Dame H. S. 17 Curtis Rd., Springfield, Delaware Co. – Microscopic Algae of the Northwestern Section of Delaware County, Pa.
Northampton	*Christman, Judith Irene (17) Northampton H. S. R. D. No. 1, Box 53 Ion Exchange Chromatography
Philadelphia	Jefferys, William Hamilton III (17) Episcopal Academy 365 Belrose Lane, Radnor – An Amateur's Radio Telescope
Pittsburgh	*Lois, Suellen Marie (17) Sacred Heart H. S. Box 102A Harcourt Dr., Route 7, Greensburg – The Photoelectric Effect Applied to Control of Artificial Street Lighting
Punxsutawney	Henry, Cyrus Pershing (17) Punxsutawney Area Joint H. S. Box 137 Big Run – Experiments on the Distillation of Crude Coke Oven Tar
State College	Winter, Harry Clark (16) State College Sr. H. S. 505 S. Pugh St. Experiments in Electrophoresis
Tarentum	Koh, Robert (16) Tarentum H. S. 1118 Park St. Bonding of Silver Brazed Stainless Steel Joints
Villanova	*Ball, Barbara Ann (17) Academy of Notre Dame 335 Upper Gulph Rd., Strafford, Wayne – Presence of Dirt and Metallic Substances in Commercial Soaps

West Lawn — Zwicky, Arnold Melchior, Jr. (17) Wilson Joint H. S. 24 Valley Rd., Wyomissing — An Inductive Analysis of the Patterns of Recurring Decimals

Westtown — Carroll, George (17) Westtown School Rt. 1, Berwick, Pa.
Report on the Ciliates in the Arboretum Pond

RHODE ISLAND

Barrington — Cameron, Alan Garrott (17) Barrington H. S. 5 Sachem Rd.
Experimenting with Transistorized Oscillators

Providence — Carleton, William Michael (17) Hope H. S. 273 Rochambeau Ave. 6
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SOUTH CAROLINA

Columbia — Wyman, Bostwick Frampton (16) Dreher H. S. 4408 Woodside Haven Dr. — A Study of Geometry in N Spatial Dimensions

SOUTH DAKOTA

Hot Springs — Schnute, Jon Theodore (17) Hot Springs H. S. 106 S. Connor St., Box 849 — Applications of the Differential Calculus to Polar Equations

Yankton — Cihak, Robert James (17) Yankton H. S. 306 Maple St.
The Resolving Power of a Lens

TENNESSEE

Bristol — Bushore, Arthur William (17) Bristol H. S. 700 Georgia Ave.
Designing and Building Plasma Jets

Chattanooga — Mallette, Vincent de Paul, Jr. (18) The McCallie School 7249 E. Brainerd Rd. 11 — An Electrical Combination Lock

Erickson, Harold Paul (18) Notre Dame H. S. 2710 E. 12th St. 4
Design and Construction of an Electronic Saxophone

Knoxville — Johnson, Charles Edward (17) Central H. S. 5102 Holston Dr. 14
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TEXAS

Alvin — Hankamer, Jorge Elwood (17) Alvin H. S. 2007 Blum St.
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Austin — Feuerbacher, David George (17) S. F. Austin H. S. 3111 Dancy St. 2
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Hurt, Ronald Wayne (17) S. F. Austin H. S. 6400 Arnold Dr. 5
Factors Affecting the Stability of Porphyrins

*Moses, Mary Catherine (17) S. F. Austin H. S. 2500 Winsted Lane 3
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Pratt, Terrence Wendall (17) McCallum H. S. 5001 Ridge Oak Dr. 3
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Coleman — Fischer, Michael Christian (17) Coleman H. S. 419 E. Tenth St.
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Dallas — Goode, John Vivian (17) Hillcrest H. S. 4656 Miron Dr. 20
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UTAH

Logan — Thorne, Kip Stephen (17) Logan H. S. 226 W. 1st South
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Salt Lake City — Linford, Gary Joe (17) East H. S. 2244 S. 20th East
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VERMONT

Shoreham — Menard, Dwight Thomas (17) Shoreham H. S. Shoreham
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Arlington — Taylor, Albion Dennis (16) Washington-Lee H. S. 2319 N. Nottingham St. 5 — Orbital Calculus

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Endocrinology and the Effects of Hormones

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WISCONSIN

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Positive Ions Affect Living Tissue

➤ Positively charged air particles or ions have now been found to cause changes in living tissue, just as their negatively charged counterparts do.

When the trachea or windpipe of rabbits was exposed to the positive ions the mucus flow was slowed down and the tissue became much more sensitive to mechanical damage, Drs. Albert P. Krueger and Richard F. Smith, University of California, Berkeley, reported in the December Proceedings of the Society for Experimental Biology and Medicine.

Negatively charged ions have been reported to help cases of asthma and hay fever as well as reduce the pain in bad burn cases. Earlier reports about positive ions, however, indicated that they caused stopped-up noses and headaches, so their effects were studied on the rabbit trachea.

The action of the cilia, the tiny hairs that help move mucus and foreign particles along the trachea, was slowed down from the normal rate of 1,400 to 1,500 beats per minute to 1,100. Sometimes it was stopped altogether by the positively charged air.

The mucus flow and clearing ability also decreased markedly or completely stopped, the researchers reported.

The positive ions made the cilia peculiarly vulnerable to mechanical damage. A gentle swab with wet cotton stopped them from beating when the tissue was receiving positive ions.

It is not at all obvious why air ions should have any ability to influence tissue. Nevertheless, evidence is collecting which proves that it does, the authors concluded.

Book Condensations

Source Book of Industrial Solvents: Volume II, Halogenated Hydrocarbons — Ibert Mellan — *Reinhold,* 267 p., illus., $7. A reference work for workers in industries using solvents.

Experimental Crystal Physics — W. A. Wooster — *Oxford University Press,* 115 p., illus., $2.90. Containing simple experiments intended to teach the fundamentals of the subject.

The Path of Carbon in Photosynthesis — J. A. Bassham and M. Calvin — *Prentice-Hall,* 104 p., illus., $3.00. One of the most intriguing problems facing scientists is the method of discovery by which the green leaf converts the sun's energy into human food.

Dynamic Aspects of Biochemistry — Ernest Baldwin — *Cambridge University Press,* 3d ed., 526 p., illus., $5.50. For undergraduate students, organic chemists and clinicians.

New Chemistry — Willard F. Libby and others — *Simon and Schuster,* 206 p., illus., paper, $1.45. A sampling of modern advances in this science.

Introduction to Protein Chemistry — Sidney W. Fox and Joseph F. Foster — *Wiley,* 459 p., illus., $9.50. Intended as a readable, integrated and relatively comprehensive introduction to the field presenting the rudiments of knowledge.

Modern Miracles of the Laboratory — Frank Ross, Jr. — *Lothrop, Lee and Shepard,* 224 p., illus., $3. Telling young people the history of chemistry from the earliest development of pottery and dyes.

Catalysis in Practice: A Collection of Papers Originally Presented in Philadelphia, Pa., in April, 1957, Under the Auspices of the Philadelphia-Wilmington Section of the American Institute of Chemical Engineers and the School of Chemical Engineering, University of Pennsylvania — C. H. Collier, Ed. — *Reinhold,* 153 p., illus., $3.95. Actual methods, economics and problems as presented by leading practitioners in chemical process industries.

Automobile Exhaust and Smog Formation — W. L. Faith, N. A. Renzetti and L. H. Rogers — *Air Pollution Foundation,* 103 p., illus., paper, $3.00. This report summarizes the work done to date and points out the obstacles to finding adequate methods of controlling automobile exhaust emissions.

Microchemical Journal, Vol. I, No. 1 — Nicholas D. Cheronis and others, Eds. — *Interscience* for Metropolitan Microchemical Society, Semiannual, 166 p., illus., $9.60 per year. A journal devoted to the application of microtechniques in all branches of science.

A Manual of Paper Chromatography and Paper Electrophoresis — Chichard Block, Emmett L. Durrum and Gunter Zweig — *Academic,* 2nd ed., 710 p., $12.80. A practical manual of tried and proved procedures, with classified bibliography of over 1800 articles.

Elementary Quantitative Analysis — Harold F. Walton — *Prentice-Hall,* 342 p., illus., $5.75. Intended for a one-semester course.